TRAINING SCHOOL

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TECHNICAL TRAINING DEPARTMENT

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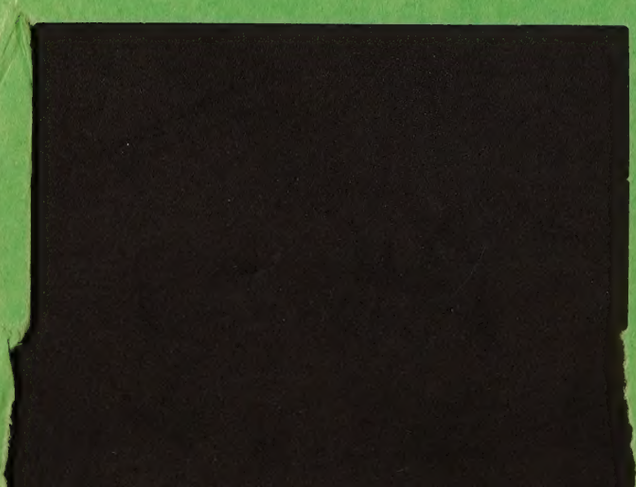

TECHNICAL
TRAINING
DEPARTMENT

COURSE NO. TP

REMOTE CONTROL CONSOLE

T1360 SERIES

OROLA COMMUNICATIONS AND ELECTRONICS INC. A SUBSIDIARY OF MOTOROLA, INC.

MOTOROLA
COMMUNICATION and ELECTRONICS, INC.

REMOTE CONTROL CONSOLE T1360 SERIES

COURSE No. TP

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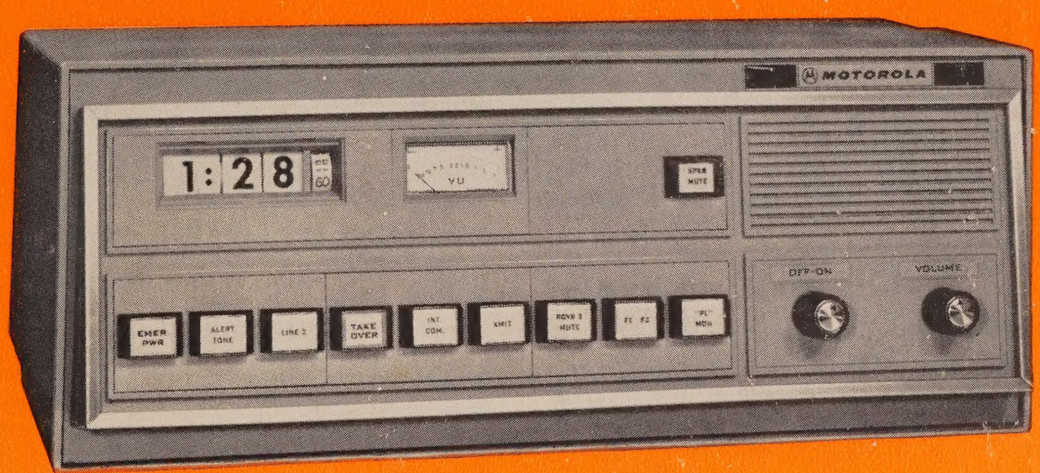
Remote Control Console and Desk Sets

Modern Control Accessories for 2-Way Base Stations



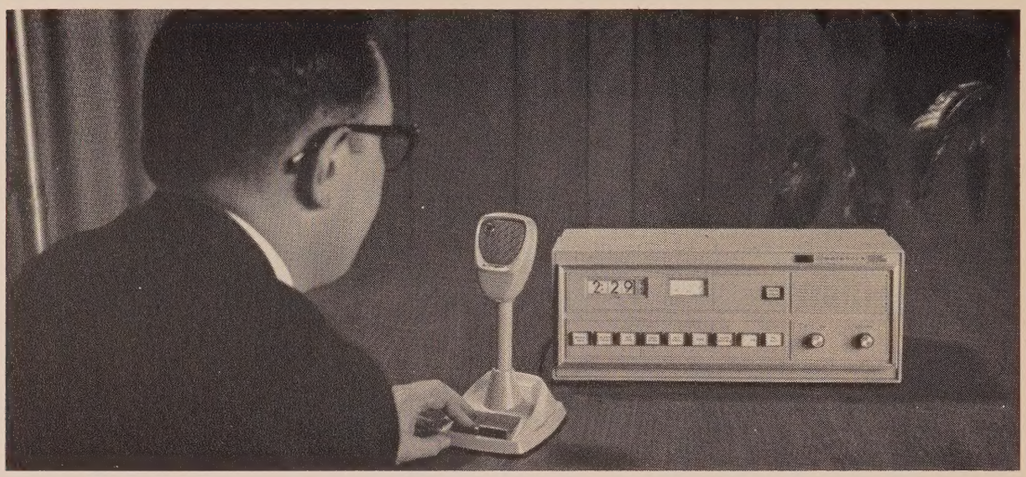
Solid-State Remote Control Console shown with optional features

Remote Desk Set

Local Desk Set

Enjoy Complete Flexibility of Control with These Attractive, Highly Functional Units for Control and Dispatch Points

Solid-State Remote Control Console



Features

COMPACT, MODERN STYLING—Motorola's Solid-State Remote Control Console is so compact, takes up so little space on a desk, you'll find it hard to believe it offers complete, *fingertip* remote control of your entire radio system. Besides its highly functional design, the Solid-State Remote Control Console features an attractively styled cabinet that will enhance virtually any modern office decor. Lighted pushbutton switches, providing up to ten control functions, let you see your operational status at a glance. Beauty and durability are combined in the beige, impact-resistant plastic housing, ensuring stylish appearance for years to come.

SHARP, CLEAR MESSAGES—A compression amplifier *automatically* maintains constant audio output at any desired predetermined level in both "transmit" and "receive" modes of operation; no further adjustment is necessary. You get automatic compensation for different voice levels among operators, or for line circuit losses. Five watts of low-distortion audio output provides sharp, clear messages that can be heard over the background noise of business and industry.

POSITIVE STATION CONTROL—Stable base station control is ensured through a new, *constant current regulation* system that automatically provides the exact current needed at the base station despite wide variations in line resistance.

HIGH RELIABILITY—This state-of-the-art unit gives you unmatched reliability in two big ways. First, the exclusive use of solid-state devices means that there are no tube filaments to burn out, no relay contacts to pit or corrode, fewer parts to fail. In addition, a solid-state unit remains cooler, protecting *all* components from the deteriorating effects of heat. Second, this solid-state circuitry is fully enclosed in a high-impact, plastic housing to minimize the effects of dust, dirt and splashing water. Inside and out, the Solid-State Remote Control Console is built to give you the utmost in reliable operation.

DC EMERGENCY CAPABILITY—Dual-voltage input models are available for 117 VAC/12 VDC operation. During a power failure, blown fuse, or other interruption of normal service, you can operate these Remote Control Consoles from a 12-volt battery power source. When power has been restored, the green pilot lamp lights up, indicating that the unit may be returned to 117 VAC operation. These models let you retain vital system communications when you're likely to need it most!

FLEXIBLE CONTROL FACILITIES—The basic unit includes, as standard equipment, a panel-mounted volume control, a full five-inch loudspeaker, built-in Dispatcher-Monitor capability, a "transmit" Pilot Lamp, and an ON/OFF Switch and AC Power Pilot Lamp. Two or more Consoles can be operated "in parallel," and Remote or Local Desk Sets may be added, to serve as additional radio "dispatch" points in other offices or departments.

Options

Never before have so many options been available to tailor the Solid-State Remote Control Console to your exact needs. These options are available factory installed, or as simple "add to" kits for easy field installation. You can get a Console with exactly those functions you need now, and add others later as your control requirements increase.

TWO-FREQUENCY CONTROL OPTIONS—A two-frequency control switch permits operation of dual-frequency base station from remote control site. Another, optional "Mute Rcvr 2" switch enables you to mute the secondary-frequency receiver when operating a two-receiver, carrier squelch or "Private-Line" squelch base station.

SUPERVISORY SWITCH—Supervisory "Take-Over" switch provides control of other Consoles, Remote Desk Sets, or Local Desk Sets operating on the same control line. This is a *required* control feature for systems with more than one operating point, in compliance with FCC Regulations.

INTERCOM SWITCH—Permits 2-way intercommunication between other Remote Control Points, Desk Set Dispatch Points, and the base station.

LINE TRANSMIT INDICATOR—Optional circuit illuminates Transmit Pilot Lamp when base station transmitter is being keyed from a parallel Remote Control Console or Remote Desk Set. FCC Regulations *require* this feature for parallel remote installations.

ALERT TONE—Provides an audible, 1000-cycle tone as an alerting device before the actual voice transmission. Also provides a convenient test-tone source for system adjustments.

VU METER—Volume Unit meter provides constant visual indication of both transmit and receive audio line levels.

PANEL-MOUNTED 12 OR 24 HOUR CLOCK

TRANSMIT SWITCH—Provides the convenience of a panel-mounted transmit switch in addition to, or instead of, the usual desk stand microphone transmit switch, if desired.

"PRIVATE-LINE" MONITOR SWITCH — In "Private-Line" tone-coded squelch systems, this option provides the convenience of a panel-mounted "Private-Line" disable switch in addition to, or instead of, the usual desk-stand microphone monitor switch, either of which may be used to monitor the channel before transmitting.

SPEAKER MUTE CONTROL—Especially useful during continuous monitoring, this option permits the receiver audio level to be reduced to a predetermined amount.

LINE COMPENSATION—This special option compensates for excessive high-frequency attenuation in the control line, sometimes encountered in systems requiring exceptionally long telephone lines.

ALTERNATE LINE CONTROL—Alternate Line function switches console output to a second control line, enabling remote control of an alternate "standby" station for systems will this special requirement.

Desk Sets for Control and Dispatching

Remote Desk Set

Motorola's Remote Desk Set may be used as the sole control device for a remotely-operated base station using a two-wire telephone line or equivalent. The Remote Desk Set is also ideal as an additional remote dispatch point when connected in parallel with a Solid-State Remote Control Console. The basic model includes a volume control, built-in speaker, and transmit indicator lamp. A push-to-talk switch in the handset provides easy, one-hand operation.

Key features and options include:

- **SOLID-STATE COMPRESSION AMPLIFIER** ensures constant audio output in both "transmit" and "receive" modes. Remote Desk Set features the same compression amplifier circuitry used in the Solid-State Remote Control Console.

- **ALL-SOLID-STATE-CIRCUITRY** for maximum reliability and highest performance.

- **EMERGENCY BATTERY POWER CAPABILITY** is provided in optional 117 VAC/12 VDC models to keep your radio system "on-the-air" despite a power failure or similar emergency.

- **OPTIONAL INTERCOM SWITCH** provides two-way intercommunication between Remote Desk Set and other operating positions equipped with this feature. A Speaker-Microphone lets you intercommunicate between the Remote Desk Set and other operating points without lifting the handset.

- **OPTIONAL "PRIVATE-LINE" MONITOR** switch disables "Private-Line" tone-coded squelch to let you monitor the channel before transmitting.

- **TWO-FREQUENCY OPERATION** is provided by optional F1/F2 switch for remote control of two-frequency base station.

Local Desk Set

Motorola's Local Desk Set is designed for convenient base station control over a multi-conductor cable up to 100 feet in length. Use a Local Desk Set for extended-local control of your entire radio system, or as an additional Dispatch Point. This unit offers the same modern, telephone-like styling and convenience as the Remote Desk Set. Local Desk Set also permits intercommunication between dispatch and control points. The basic model includes a volume control, built-in speaker, transmit indicator lamp, and "Private-Line" Monitor Switch.

An optional "Control Point" model, designed for extended-local control of the Transistorized Consolette Radio, is equipped with the required "Take-Over" Switch to provide supervisory control over other Local Desk Set dispatch points.

Choice of Six Colors for All Desk Sets

Both Remote Desk Sets and Local Desk Sets are available in any of six decorator colors: White, Beige, Blue, Green, Red and Black. Select the color that best matches the decor of your office. Whatever your choice, the clean, functional styling of these telephone-type units will give your operation the look and feel of modern radio control.

Remote Control Console and Desk Sets

GUARANTEED PERFORMANCE SPECIFICATIONS

GENERAL

MODEL		SOLID-STATE REMOTE CONTROL CONSOLE T1360-Series	REMOTE DESK SET T1375-Series
POWER INPUT 117 VAC	Transmit	41 watts*	15 watts
	Receive	30 watts*	7 watts
	Standby	25 watts*	5 watts
POWER INPUT 12 VDC	Transmit	850 ma.	600 ma.
	Receive	750 ma.	170 ma.
	Standby	600 ma.	75 ma.
DC CONTROL CURRENTS		Adjustable and Regulated: Currents regulated to less than 5% variation over input voltage range variation ±20%, and loop resistance variation from 0 to 8000 ohms (Not Referenced to Ground)	Adjustable: Nominal ±5.5 and +12.5 ma, −2.2 ma
WEIGHT		Approximately 15 lbs. (With all options: Approx. 23 lbs.)	Approximately 5 lbs.
DIMENSIONS		6½" high x 16½" wide x 8" deep	5" high x 9⅜" deep x 9" wide

*Includes 4.0 watt clock drain

TRANSMIT

	REMOTE CONTROL CONSOLE	REMOTE DESK SET
MICROPHONE INPUTS	Requires low-impedance, dynamic type microphone with built-in pre-amplifier	Includes Dynamic-Type Cartridge in handset
SENSITIVITY AT BEGINNING OF COMPRESSION	Adjustable: Max. sensitivity: 100 mv	Fixed: 200 mv ±3db
FREQUENCY RESPONSE (1000 cps reference)	+1, −3 db @ 300-3000 cps	
COMPRESSION	with audio input increase of 30 db beyond start of compression, output level increases less than 3 db	
SIGNAL TO NOISE	more than 50 db	
AUDIO OUTPUT	18 dbm at less than 3% distortion with 30 db of compression into a 600-ohm load from 95 to 145 VAC input	

RECEIVE

INPUTS	600-ohm line (balanced)	
AUDIO INPUT LEVEL FOR START OF COMPRESSION	Adjustable, maximum sensitivity: −20 dbm @ 1000 cps	
FREQUENCY RESPONSE (1000 cps reference)	+1, −3 db, 300-3000 cps	
COMPRESSION	with audio input increase of 30 db beyond start of compression, output level increases less than 3 db	
SIGNAL TO NOISE	better than 50 db (Remote Control Console)	better than 45 db (Remote Desk Set)
AUDIO OUTPUT	5 watts min. into a 3.2 ohm load (Remote Control Console) or 500 mw min. into a 16 ohm load (Remote Desk Set), @ less than 5% distortion with 30 db of compression from 95 to 145 VAC	
TRANSFORMER LINE BALANCE	70 db @ 1000 cps	
LONGITUDINAL HUM REJECTION	Signal to noise is better than 40 db (Remote Control Console) or better than 35 db (Remote Desk Set), with 100 VAC, 60 cps line to ground	

LOCAL DESK SET

MODEL	T1370-Series
MICROPHONE TYPE	Dynamic Cartridge
RECEIVER ELEMENT	Magnetic Type
OUTPUT IMPEDANCE	500 ohms
SPEAKER SIZE	3 inches
SPEAKER INPUT IMPEDANCE	3.2 ohms
DIMENSIONS	5" high x 9⅜" deep x 9" wide
WEIGHT	4 lbs. without interconnecting cable

Specifications subject to change without notice

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E-769A
(Replaces E-769 and E-214F)

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PART I. INTRODUCTION

Course No. TP has been designed to cover the T1360 series of Remote Control Consoles.

This series of Remote Console is fully solid state and is used to provide control of a base station from one or more remote locations.

Remote control can be accomplished by the full Remote Console (T1360) or by a telephone sized Remote Desk Set (T1375).

The Remote Desk Set is a complete self-contained remote control unit.

These remote control units are compatible with the new solid state Remote Termination Chassis and the older relay type Remote Termination Chassis. They can also be intermixed in a system containing the older T1200 series Remote Consoles.

The Course Outline is divided into six sections. These sections cover: The use of telephone lines for remote control and some of the problems. The types of remote consoles in use. The T1360 and T1375 series remote consoles in detail, levels, adjustment of levels, and troubleshooting procedures.

A thorough knowledge and understanding of the information contained in Course TP will greatly increase the technician's servicing proficiency in working with the T1360 series of Remote Consoles.

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TP-II
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REMOTE CONTROL CONSOLE T1360 SERIES
COURSE No. TP

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B. REMOTE CONSOLE T1360 SERIES

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1. Motorola DC Multimeter S1063A
2. Motorola AC Voltmeter S1053A
3. Motorola Solid State Audio Oscillator S1067A
4. 600 Ohm 2 Watt Load Resistor
5. Optional - Motorola Oscilloscope T1014 or T1015

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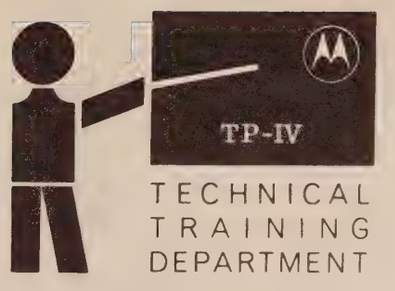


REMOTE CONTROL CONSOLE T1360 SERIES

COURSE No. TP

TEXT

I. INTRODUCTION

When a radio system is set up it is frequently much more convenient to have the operating point and the base station at separate locations. For this reason remote control facilities are available.

A. GENERAL INFORMATION

This remote operation calls for the use of a remote control termination chassis at the base station and a remote control console at the point of operation. These two points must connect together by a telephone channel.

The communication wire lines available for remote control operation of 2-way radio equipment are usually obtained from the facilities installed for normal telephone services. These facilities consist of conductors, non-loaded and loaded circuits, and may contain repeating coils, composite sets or other intermediate equipment. For these reasons, the resistance, impedance and transmission-frequency characteristics of lines differ, depending upon the location of the terminals of the available facilities.

Channels for service up to approximately twenty miles are usually obtained from cable facilities. Metallic paths are generally employed for such channels when speech or tones in the voice range are to be transmitted. When initially connected, it may be found that the pair does not transmit DC.

The telephone company may have repeat coils installed in the line, therefore it may be necessary to provide for DC transmission. The communications-center consoles can provide DC control over the same pair as used for audio (two-wire control). Only single-station control consoles can use separate wires for DC control (four-wire).

When circuits are longer than twenty miles, the telephone company may be unable to provide communications circuits which will transmit frequencies below 250 cycles, as required for Private Line tones; therefore the DC control will have to be on a separate pair. The upper limit of the frequency band transmitted is generally limited by the cut-off frequency of a loading system which is approximately 2750 cycles to 3500 cycles. Where non-loaded facilities are employed for channels above 3000 cycles, the telephone company may load these circuits for general service reasons.

Motorola consoles are designed to meet all telephone company specifications, regarding specific levels and DC voltages impressed on the line.

B. STATION REQUIREMENTS

Many base stations are remotely located from the station operator. This means that the operating or control point may be anywhere from a few feet to several miles from the actual transmitter and receiver installation. Therefore, some means must be used to remotely control and operate the various functions of the transmitter and receiver. A remote control console is generally used for this purpose.

To operate the base station, some interconnections between the remote console and the radio equipment are necessary. Normally, a single pair of telephone wires are used. In its simplest form two main functions are required for remote control. These two functions are keying the transmitter on and off and conveying the audio intelligence to and from the remote station. For more complex systems it may be necessary to control several other functions such as: selection of channel frequency, tone modulation of transmitter, disabling the squelch or "Private-Line" function, receiver monitoring, and others.

1. REMOTE TERMINATION CHASSIS

Even in more complex systems there are still two basic functional categories, one to carry the audio, and the other to key the transmitter. In order to do this over a single telephone pair, two signals are used. The AC signal, of course, is the audio intelligence. Control functions at the remote station are carried out by means of DC voltages being applied to the same pair of wires.

A remote termination chassis is used at the transmitter and receiver to apply the various

signals to the radio equipment. The chassis has a 500/600-ohm line transformer to match the audio into the transmitter and the output of the receiver to the line. The primary of the transformer is split and the two halves are coupled together with a capacitor to complete the audio circuit. This is necessary in order to feed the DC signals down the line.

In the past the DC component was taken from the two wires and fed to relays mounted on the termination to control the proper transmitter functions.

Today a completely solid state remote termination chassis is used. The DC component is taken from the two wires and fed to transistorized circuits to control the proper transmitter functions.

In order for the transmitter audio and modulation circuits to function properly, certain audio requirements must be met. The transmitter has a fixed modulation sensitivity. This refers to the value of the audio voltage required at the transmitter for maximum deviation or 100 per cent modulation. On the older tube type base station this level was set at . 18 volts AC or . 25 volts AC. On the newer transistorized base station the modulation sensitivity is individually marked on the exciter chassis. These levels are based on a 1000 cycle tone.

It is important that the average audio level feeding the transmitter be as close to this level as possible. If the average level were considerably below this point, low audio output from the associated receivers would result. On the other hand, if the average audio level is too high, severe clipping could result in distortion.

In contrast to this requirement for a relatively low audio level required by the transmitter, another requirement must be met. There is nearly always a certain amount of noise on a telephone line. If this noise level is anywhere near the audio level, a poor signal to noise ratio and reduced intelligibility will result. Since the noise level for a given telephone line is relatively constant, we can combat this poor signal to noise ratio by raising the audio level impressed on the line considerably above the noise level.

Raising the audio level in this manner generally results in excessive audio level at the transmitter. To compensate for the high audio level, attenuation (Line Input Control) is used on the remote termination panel to reduce the available audio to the required level for proper transmitter deviation.

Another audio requirement for remote operation is the proper frequency response. Many tests have been conducted to determine the optimum frequency range for voice communications. From these tests it has been determined that speech intelligibility is carried mainly in the 300 to 3000-cycle portion of the audio frequency range.

In order to have good communications, an audio line with a reasonably flat frequency response over this range of 300 to 3000 cycles is needed. While this does not present much of a problem on shorter lines, longer lines can introduce enough attenuation of the higher frequencies that some form of equalization may be necessary.

2. REMOTE CONSOLE

It may be desirable to remotely control the base station from several different locations resulting in multiple control points for one base station. This can be readily accomplished by the use of two or more remote control consoles. Several consoles may be connected in parallel on the remote line to provide control from additional points. When this is done the base station can be operated from any of the remote consoles.

With the Motorola T1200 and T1360 series of remote control consoles, additional accessory kits are available to give one of the remote control consoles of the system supervisory control of the transmitter. The operation at the main dispatch point can then prevent any of the other remote units from keying the transmitter. This permits the operator at the main dispatch point to take over control at any time for a priority message. It also permits him to disable the transmitter at any time for an emergency.

There are several types of remote consoles in use and available. A brief description of the older T1200 series will be given, as well as the new T1360 series Remote Console and the T1375 series Remote Desk Set. Only the T1360 and T1375 series remotes, however, will be covered in detail.

a. T1200 Series Remote Console

The T1200 series Remote Control Console (Figure 1) is a modular type of unit. That is, it is available as a basic unit and various accessory modules can be added to convert the basic console into a more deluxe version. This is especially important because a relatively simple radio system does not require many of the features available, yet, as the radio system expands, the features may be added as required.

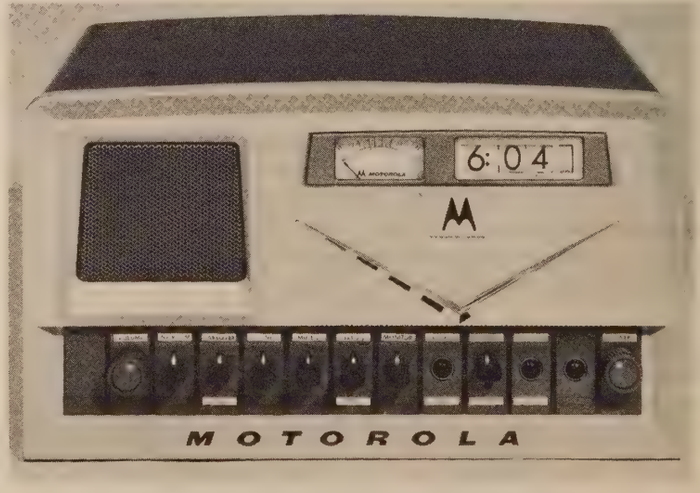


Figure 1. T1200 Remote Console

All of the controls to operate a single frequency base station are included in the basic unit.

The basic T1200 series of Remote Control Console consists of a compression type line amplifier and a microphone preamplifier. The features of this unit are: balanced line terminations and DC control voltages.

Audio amplification is controlled by the reversible compression type line amplifier. In the receive condition the remote receiver is connected to the input of the line amplifier and the output is connected to the panel speaker. When the microphone button is depressed the microphone preamplifier is automatically connected to the line amplifier input and the output is connected to the 600 ohm line to the remote transmitter. Compression in the line amplifier helps to maintain a constant output over wide variations of input levels. An increase at the input level of 30 db past the start of compression will result in a 3 db or less increase in output level.

The input and output line terminations are balanced for minimum hum and noise.

The control voltages are derived from the power supply which also provides the filament and B+ voltages for the amplifier portion.

Additional features which are standard on some models or may be added to the consoles include the following (Figure 2).

Two frequency operation is accomplished by means of a front panel switch selecting the proper DC control voltage. Also included in this accessory is a panel switch to mute the second receiver by removing B+ from it.

A panel mounted VU meter gives continuous monitoring of the audio level for both transmit and receive operation. The range of the meter is -20 to +3 VU. A cyclometer type of clock is also included as part of this accessory group.

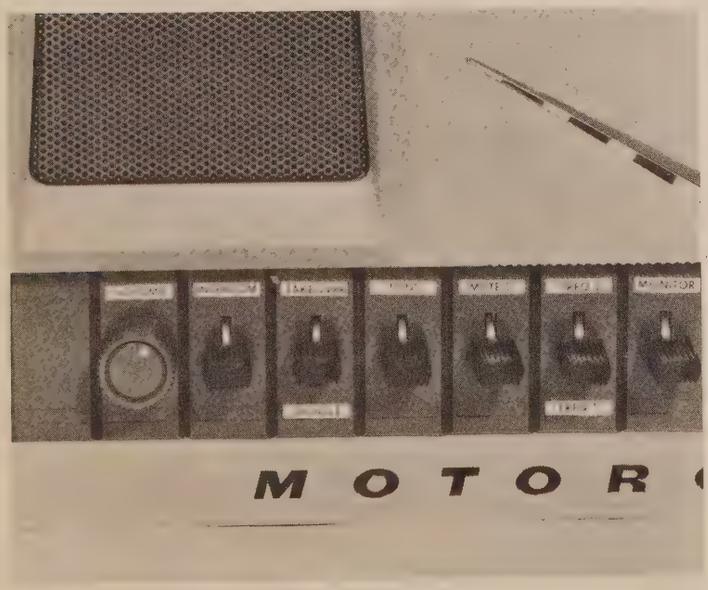


Figure 2. T1200 Close Up

"Private-Line" disabling is provided to enable the operator to monitor the channel before transmitting.

Any of these additional features may be obtained as factory installed equipment depending on the specific model ordered while the following features are optional for field installation.

A 1000 cps tone generator is available to provide an alert tone or to aid in setting up the proper audio levels.

Line equalization can be installed to compensate for high frequency loss due to the length of telephone lines used.

A three position switch gives supervisory control to one remote control console where several are used. This also provides for complete disabling of the transmitter in case of an emergency.

Carrier indication can be provided by means of a RF probe and relay kit. The panel indicator light is turned on when the RF carrier is picked up.

A transmit switch allows keying of the transmitter without using the push to talk button on the microphone.

Intercommunication between the various monitors on the line without keying the transmitter is provided by a front panel switch.

The audio receive level can be cut down to a fixed preset level by use of the partial mute kit.

A dispatcher monitor kit will permit monitoring both incoming and outgoing messages from a point other than the remote control console itself.

b. New Remote Console

The T1360 Remote Console has all of the features of the T1200 plus many others. It is completely transistorized and contains no relays. This will be covered in detail in another section of this article.

c. New Remote Desk Set

The T1375 series Remote Desk Set is a complete remote in a telephone size package. It is complete with a compression amplifier and line currents. The T1375 series Remote Desk Set will be covered later in this article.

II. T1360 SERIES REMOTE CONSOLE

A. DESCRIPTION

The T1360 Remote Console (see Figure 3) consists of a compression amplifier, a line output amplifier and a speaker amplifier and a line current section. Transistor switches are used to connect various sec-

Figure 3. T1360 Front Cover On

tions properly to perform the various functions. There are two versions available: the T1360 is an 117 VAC operated unit and the T1361 is an 117 VAC and 12 VDC operated unit.

Both units are compact in size and are housed in a textured, high impact plastic housing. The housing has a fully enclosed back (see Figure 4) to give an attractive appearance on a desk. The front panel has been attractively styled. All accessories are operated by push button switches. The switches have built-in lights to indicate the function.

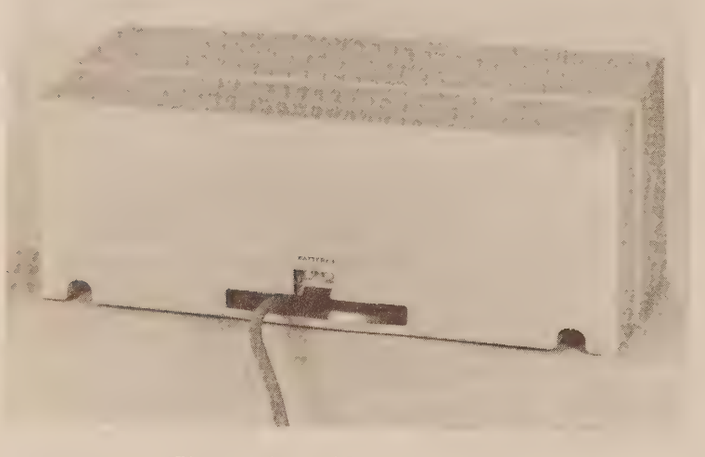


Figure 4. T1360 Back Cover

1. FEATURES

The use of transistors for all of the audio circuits and control functions increases the reliability of the unit. Since transistors are also used to perform all switching functions, all relay maintenance is eliminated.

The compression level is fixed so that there is no need for adjustment of the compression amplifier.

The compressed audio is fed to two completely separate output amplifiers. One output amplifier has an output of +18 DBM at 3% distortion. It has an output level control and a line matching transformer to feed the telephone lines with the proper level.

The second audio output has its own level setting control. It has an output of 5 watts at 5% distortion and is used to feed the speaker.

The distortion figures listed above are based on the amplifier being 30 DB into compression.

The DC line current portion features regulated line currents. This means that the line current can be set at the factory or in the shop. Regardless of changes of resistance in the line (up to a maximum value), the same current in the telephone line will be maintained. In addition there are three controls so that up to three individual current levels can be set. For other functions such as "PL disable" a negative line current is available with its own separate regulator and three controls. This gives a possible combination of six distinct line currents (three positive and three negative).

The DC line currents are isolated from chassis ground. Completely separate ungrounded power supplies are used to develop the line currents and maintain a balanced output to reduce hum.

For emergency operation the remote console can be switched to a 12 VDC battery source by means of a push button switch.

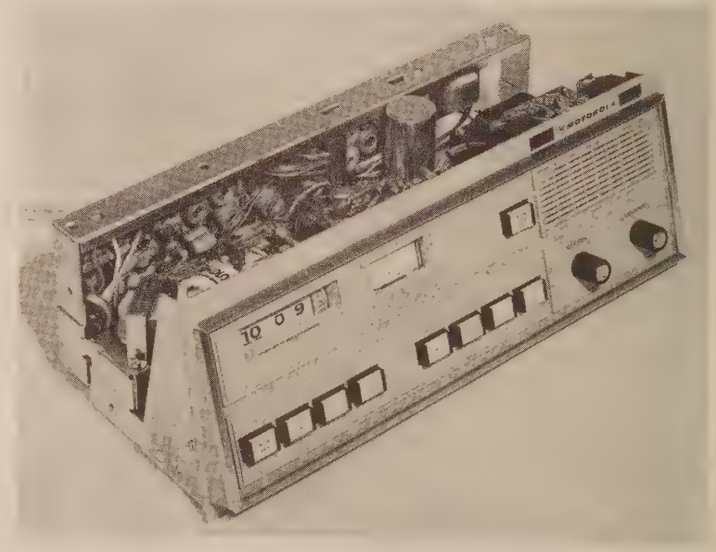


Figure 5. T1360 Housing Removed

Figure 5 shows the console with the housing removed. With the housing removed removal of two screws allows the front panel to fold down exposing the components on the back. See Figure 6.

Figure 7 shows the circuit boards mounted on the back of the unit. By removing two screws the back frame can be removed and folded down exposing the component side of the circuit boards (see Figure 8).

To gain access to the center chassis both the front and rear panels may be folded down as shown in Figure 9.

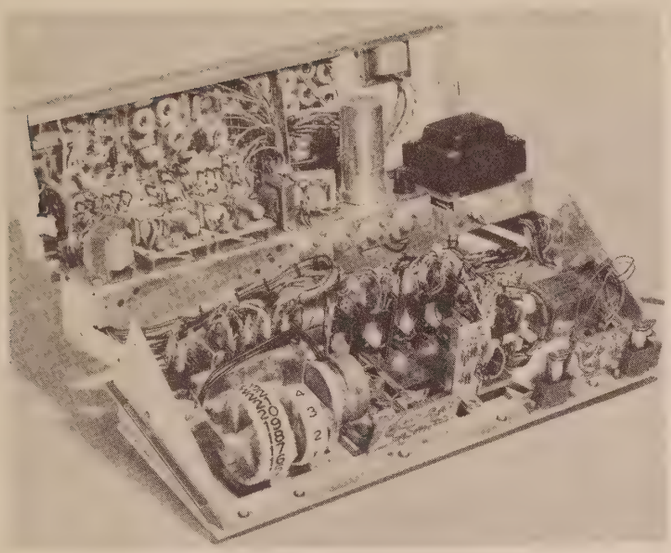


Figure 6. T1360 Front Panel Folded Down

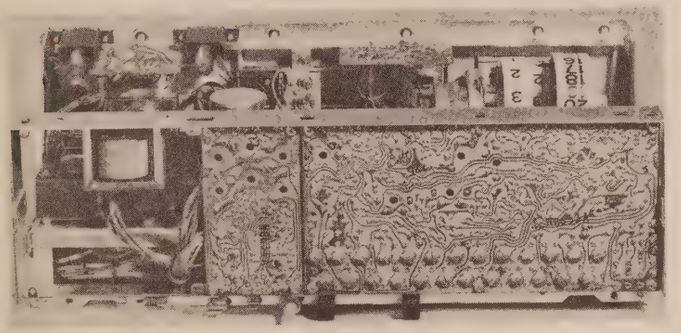


Figure 7. T1360 Back Panel

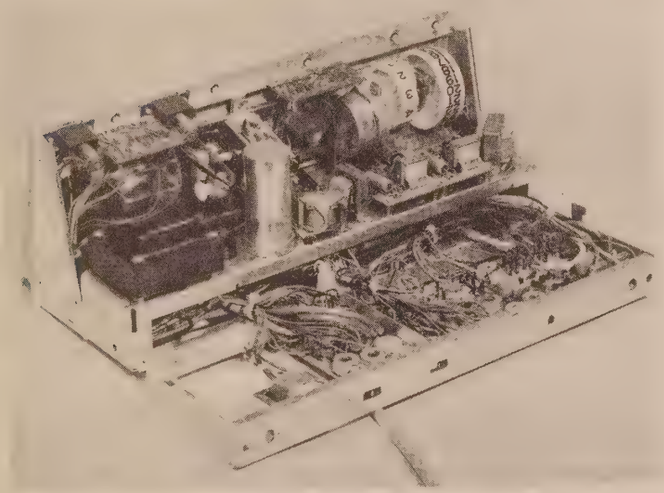


Figure 8. T1360 Back Panel Folded Down

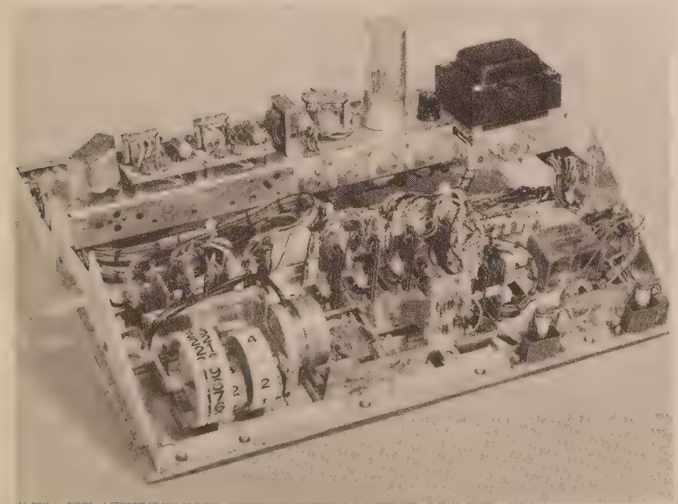


Figure 9. T1360 Front and Back Panels Folded Down

2. OPTIONS

There are many accessory options available to make the T1360 series Remote Control Consoles more versatile. These options are as follows: See Figure 10.

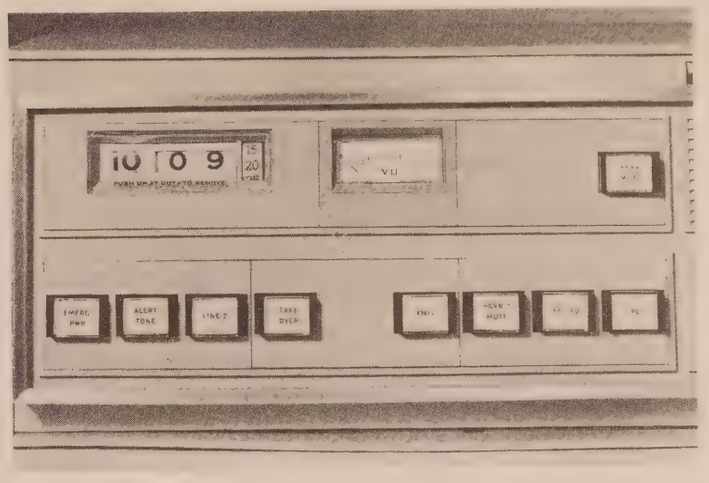


Figure 10. T1360 Front Close Up

TWO-FREQUENCY CONTROL OPTIONS — A two-frequency control switch permits operation of dual-frequency base station from remote control site. Another, optional "Mute Rcvr 2" switch enables you to mute the secondary-frequency receiver when operating a two-receiver, carrier squelch or "Private-Line" squelch base station.

SUPERVISORY SWITCH — Supervisory "Take-Over" switch provides control of other Consoles, Remote Desk Sets, or Local Desk Sets operating on the same control line. This is a required control feature for systems with more than one operating point, in compliance with FCC regulations.

INTERCOM SWITCH — Permits 2-way intercommunication between other Remote Control Points, Desk Set Dispatch Points, and with the Service Technician at the base station.

LINE TRANSMIT INDICATOR — Optional circuit illuminates Transmit Pilot Lamp when base station transmitter is being keyed from a parallel Remote Control Console or Remote Desk Set. FCC Regulations require this feature for parallel remote installations.

ALERT TONE — Provides an audible, 1000-cycle tone as an alerting device before the actual voice transmission. Also provides a convenient test-tone source for system adjustments.

VU METER — Volume Unit meter provides constant visual indication of both transmit and receive audio line levels.

PANEL-MOUNTED 12 OR 24 HOUR CLOCK

TRANSMIT SWITCH — Provides the convenience of a panel-mounted transmit switch in addition to, or instead of, the usual desk stand microphone transmit switch, if desired.

SPEAKER MUTE CONTROL — Especially useful during continuous monitoring, this option permits the receiver audio level to be reduced to a predetermined amount.

"PRIVATE-LINE" MONITOR SWITCH — Disables "Private-Line" tone-coded squelch circuit to permit monitoring the channel before transmitting.

LINE COMPENSATION — This special option compensates for excessive high-frequency attenuation in the control line, sometimes encountered in systems requiring exceptionally long telephone lines.

ALTERNATE LINE CONTROL — Alternate Line function switches console circuits to a second control line, enabling remote control of an alternate "standby" station for systems with this special requirement.

B. THEORY OF OPERATION

The operation of the Remote Console can be understood best by going through the functions in block form before going into a detailed description.

1. BLOCK DIAGRAM

The block diagram shown in Figure 11 shows the T1360 series Remote Console broken up into five major sections. These sections are as follows: the Input section, the Compression Section, the Line Output Section, the 5 Watt Local Audio section, and the DC Current section.

a. Input Section

The input section has four main audio inputs. These are the Microphone Input, the Desk Set Input, a Quik-Call Input, and a Receiver Input from the line transformer.

b. Compression Amplifier

All of the various audio inputs are combined and fed to the compression amplifier. These inputs feed through a compression stage to a four stage amplifier. The output of the four stage amplifier feeds to the output sections and also to a rectifier circuit.

The rectifier circuit has a DC output proportional to the audio level. This DC output is amplified by the DC amplifier and controls the compression stage.

At low levels the audio is amplified, but as the audio level at the output increases beyond a fixed point, a control voltage is fed back to cut down the compression stage. Once the audio reaches this level any further increase in audio input results in no further increase in audio output.

c. Line Output Amplifier

The output of the compression amplifier feeds through a level control to the Driver-Splitter of the line output section. The Driver Splitter amplifies the audio and feeds the push-pull Line Output Amplifiers with the proper phase signals. This amplifier is capable of an output level of +18 DBM. Audio from the Line Output amplifier is coupled to the telephone line by means of the line matching transformer and on to the base station.

d. Local Audio

Audio from the Compression Amplifier is also coupled through a separate level control to the driver stage of the Local Audio section. The driver stage feeds the proper signal to the 5 watt push-pull output stage and through a front panel mounted Speaker Level Control to the local speaker.

e. DC Current

Control currents for turning on the transmitter and other functions are generated in the DC Current Section. The Line Current Supplies are completely separate power supplies, one for positive control currents, and one for negative control currents. The outputs from both of these supplies are isolated from ground to minimize hum.

The output of the line current supply is connected to a constant current regulator. There is a separate current regulator for both the positive and negative supplies. Once the current regulator has been set for a particular value of current in the line, it will maintain that value even if the resistance of the telephone line changes. The output of the current regulator is connected through the line transformer for two wire operation.

2. OPERATION

The operation of the T1360 series Remote Console can be best described by separating it into four major functions: Receive, Transmit using the microphone, Transmit using a Desk Set, and Intercom.

A separate block diagram is shown for each of these modes of operation. The heavy solid line indicates the audio paths, and the red lines indicate the control and switching paths.

a. Receive Mode

Refer to Figure 12 for the receive mode of operation. The audio from the base station receiver is fed from the line transformer to the Line Input Control and on to a Line Input Amplifier.

Since neither of the push-to-talk inputs are operated, the various switches are in the condition shown in their individual boxes.

The Line Input amplifier switch is turned on so the receiver audio is amplified and passed on to the Compression Amplifier. The output of the Compression Amplifier is tied to both audio output sections (Line Output and Local Audio).

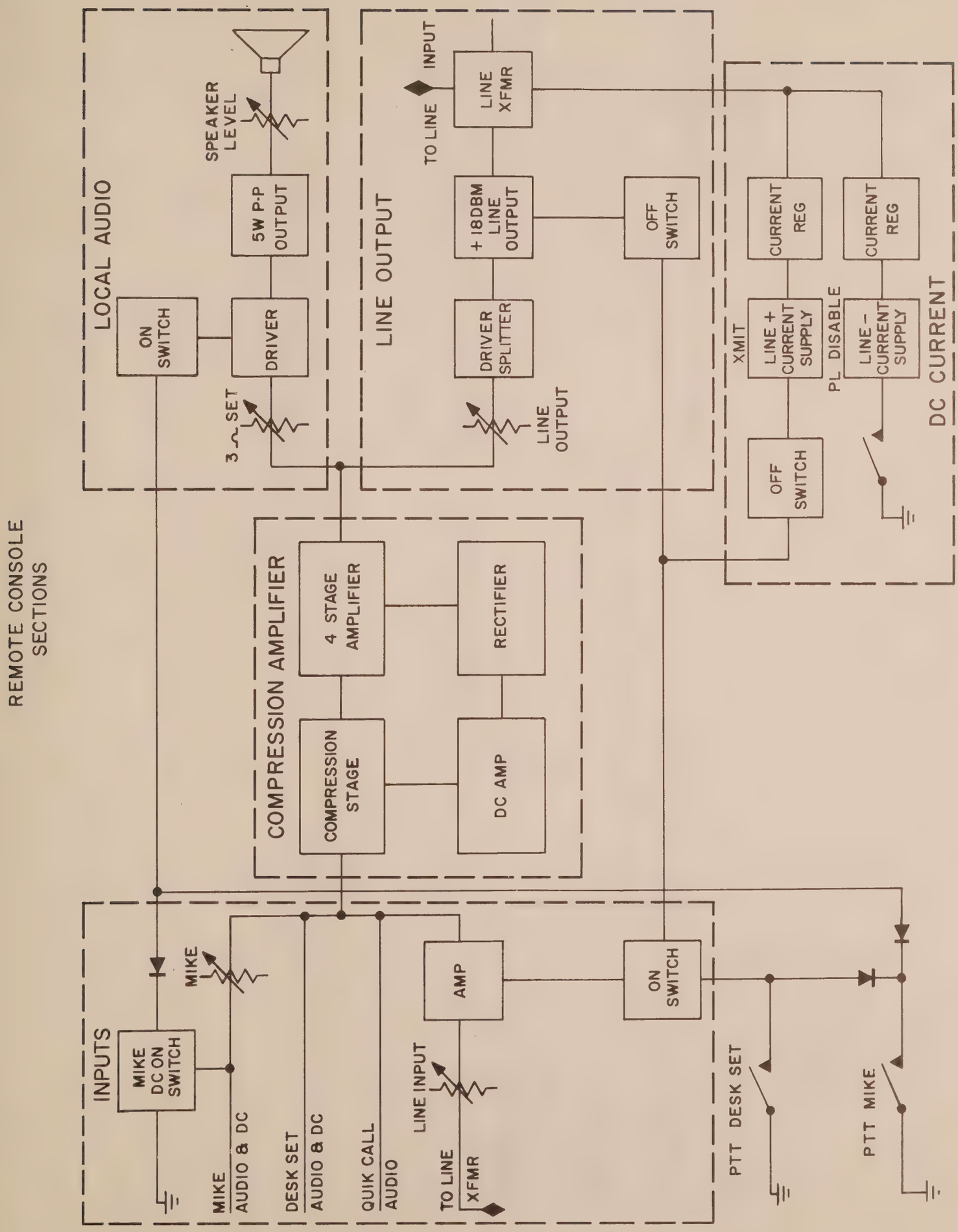


Figure 11. T1360 Block Diagram Showing Sections

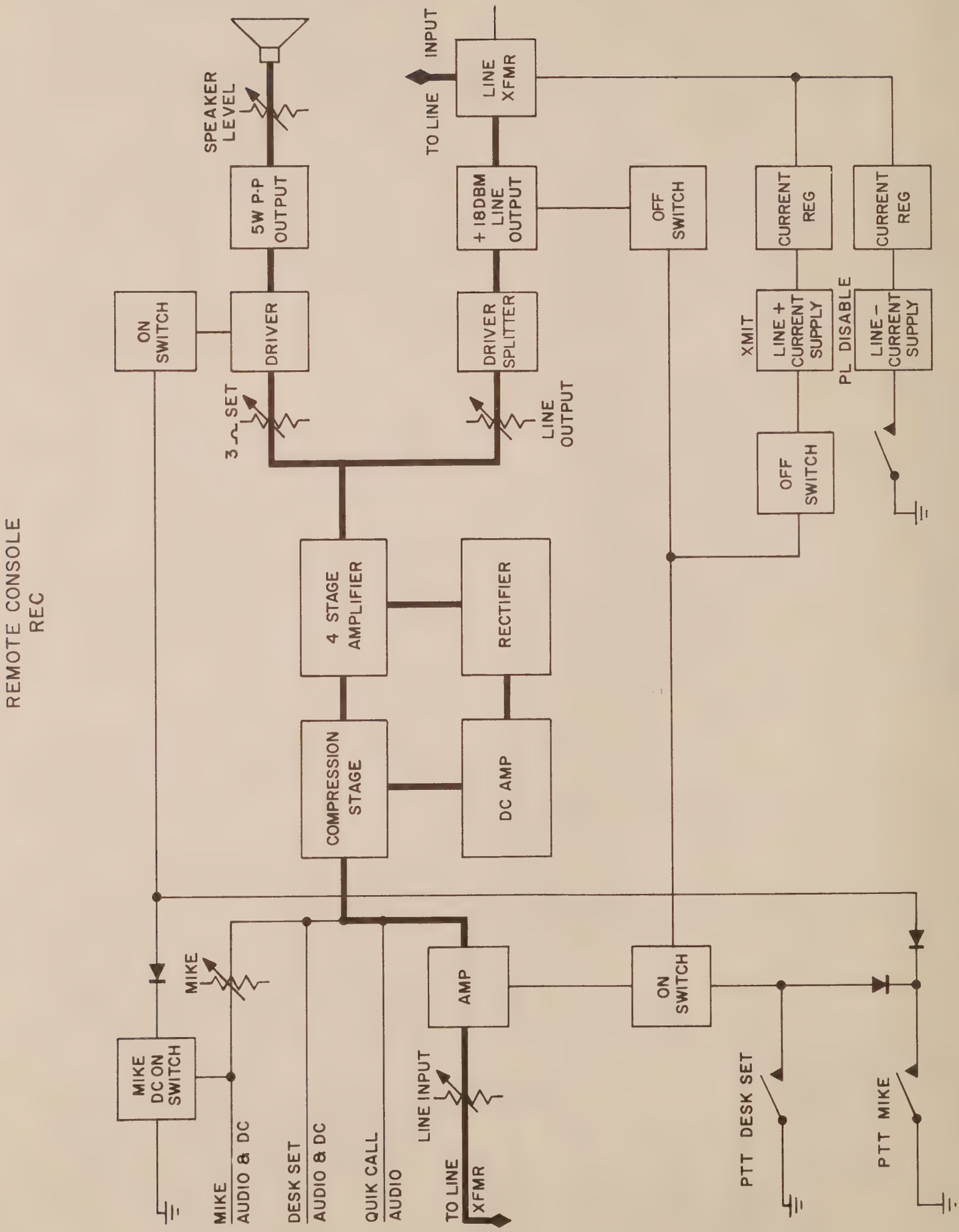


Figure 12. Block Diagram Receive Mode

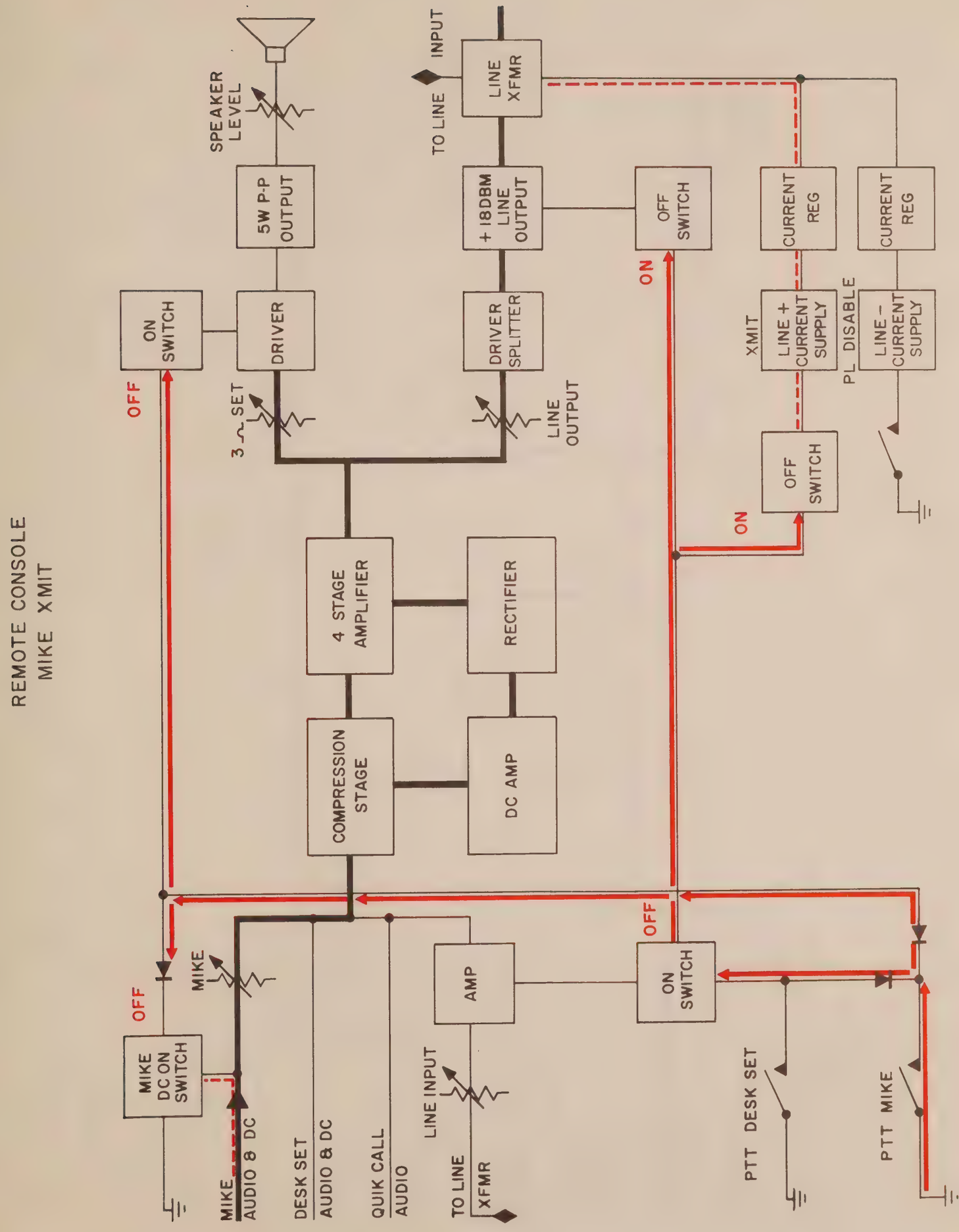


Figure 13. Block Diagram Transmit Mode Mike

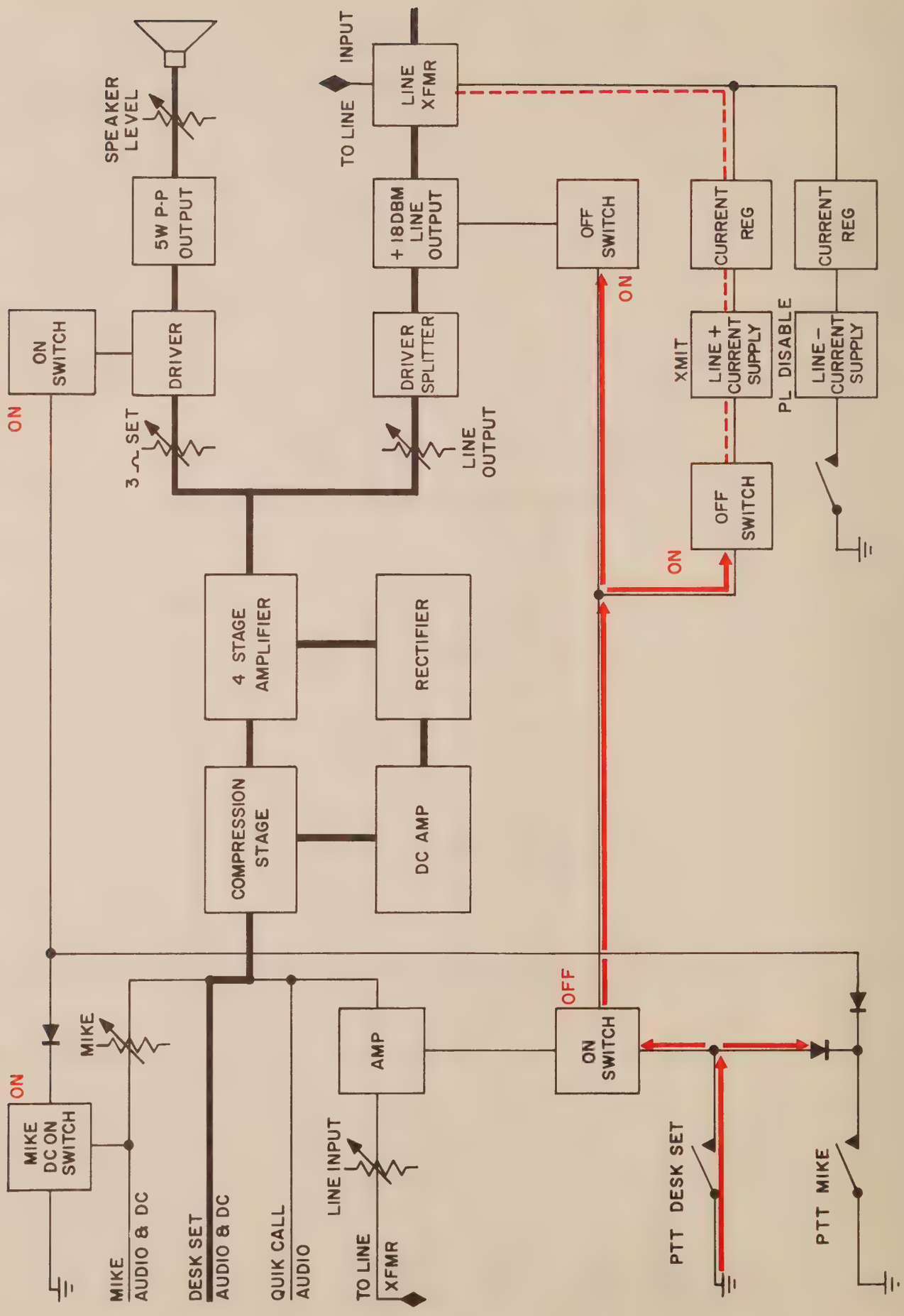


Figure 14. Block Diagram Transmit Mode Desk Set

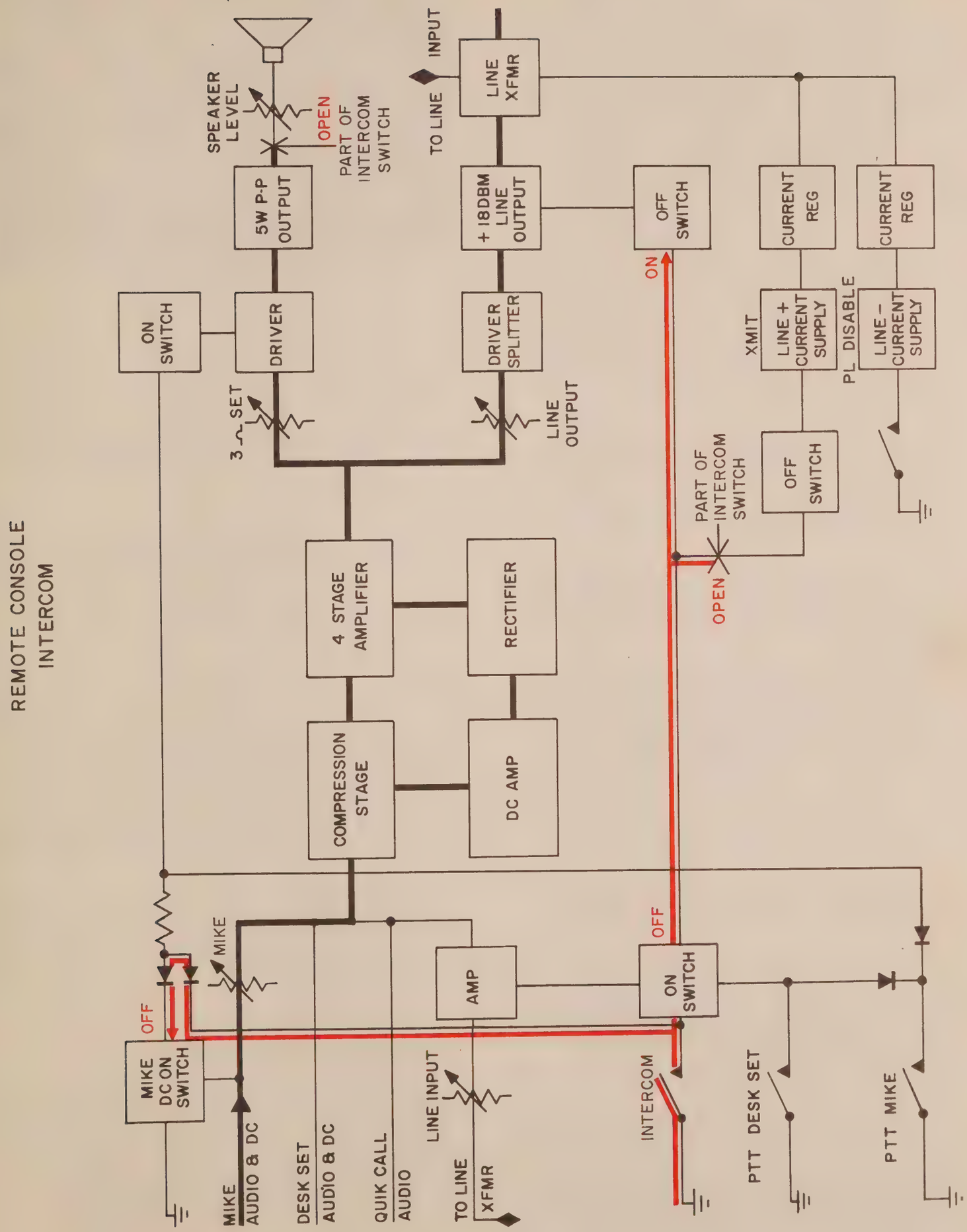


Figure 15. Block Diagram Intercom

Audio coupled to the Line Output section passes through the Driver Splitter and is applied to the +18 DBM Output Amplifier. Since the switch for this output stage is in the off condition, there is no audio output to the line.

The audio coupled to the Local Audio Section goes to the driver stage. With the driver switch turned on, the audio is coupled to the 5 watt output stage and speaker, and the receiver audio is heard at the speaker.

b. Transmit Mode (using microphone)

Refer to Figure 13 for details. The microphone is connected to "MIKE" input. When the microphone push-to-talk button is closed, the control path is shown in red. The ground (negative voltage) is coupled through the two diodes to the various switches causing them to assume the conditions shown in red on the outside of the boxes.

The microphone DC switch is turned off. This removes a ground from the microphone line and allows a DC voltage to be fed to an amplifier built in the microphone. The audio from the microphone is then fed to the compression amplifier.

Audio from the Compression Amplifier is fed to the driver of the 5 watt Audio Output Stage. The driver switch is now in the off condition and no audio is fed to the output stage and speaker.

Audio fed to the Driver Splitter of the Line Output section is coupled to the +18 DBM output stage. The Output Stage Switch is now in the on condition and the audio is fed to the telephone line through the line transformer.

At the same time the Input Amplifier switch is turned off and no audio from the line transformer can be coupled to the Compression Amplifier.

Keying of the transmitter is accomplished because the DC current section switch is now turned on also.

The DC Current Switch turns on the Line Current Supply. Voltage from the Line Current Supply is coupled through the current regulator to the telephone line and causes the transmitter to be turned on.

c. Transmit Mode (using desk set)

Refer to Figure 14 for details of this mode of operation.

When the desk set Push-to-Talk Switch is closed the ground is fed to the input amplifier switch only. A diode blocks the ground from being placed on the other switches. This leaves the microphone and local audio output switches in the on condition.

When the microphone switch is in the on condition, a ground is applied to the microphone line. This shorts out the microphone DC and mutes any audio from the microphone.

With the Local Audio Switch in the on condition, any audio coming from the Desk Set will be heard in the speaker, as well as being fed to the transmitter by the +18 DBM output. This provides the built-in Dispatcher Monitoring feature.

The Input Amplifier Switch connects to the Line Output Switch and the DC Current Switch and turns the +18 DBM output stage on to feed audio to the transmitter. It also turns the line current supply on to key the transmitter.

d. Intercom Mode

Refer to Figure 15 for the intercom mode of operation.

When the Intercom Switch is closed a ground is fed to the Microphone DC Switch to turn it off and remove the ground from the microphone line.

The same ground turns off the Line Input Amplifier Switch to prevent any audio appearing at the line transformer from being fed to the Compression Amplifier. The same control line feeds a voltage to the Line Output Switch and the DC Current Switch to turn them on.

However, there are two sets of normally closed contacts on the Intercom Switch. One set of these contacts is in series with the local audio speaker lead, and the other set is in series with the DC Current Switch. When the Intercom Switch is operated, these contacts open and prevent the transmitter keying current from being placed on the line. They also prevent any audio from appearing at the local speaker.

Thus when the Intercom Switch is operated, the microphone is activated, the local speaker is cut off, the DC control currents are cut off, and the audio is fed to the telephone line without keying the transmitter.

C. DETAILED OPERATION

For purposes of explanation the T1360 will be broken down into three major sections: the Amplifier Board, the Current Board, and the Power Supply. Most of the major circuitry is contained on the two circuit boards shown in Figure 7. Refer to schematics number Ref.A in following the detailed operation.

1. AMPLIFIER BOARD

The Amplifier Board is shown in Figure 16.

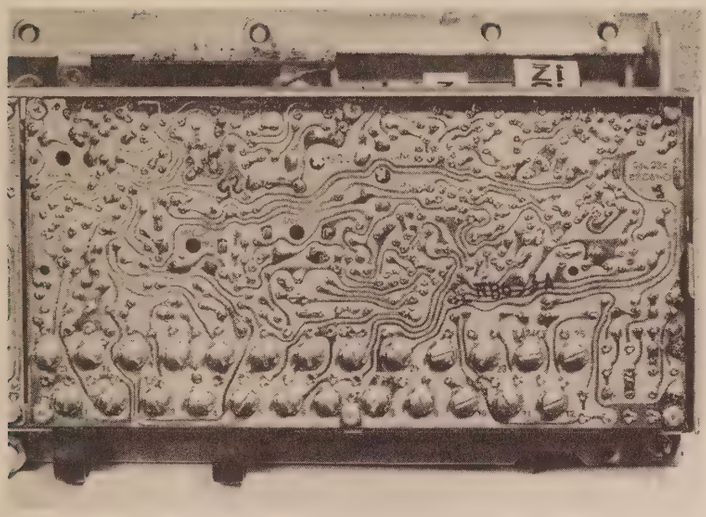


Figure 16. Amplifier Board

a. Four Stage Compression Amplifier

All of the audio inputs go to a Compression Amplifier consisting of four NPN transistors Q208, Q209, Q210, and Q211. The four transistors are all dc coupled. Q208, 209, and 210 are common emitter stages. The output stage Q211 is an emitter follower.

The output of Q211 is fed in four paths. Two of these paths are to the 5 watt speaker amplifier and to the transmit amplifier. These will be covered later.

The other paths provide negative feedback, and compression. Negative feedback is taken from the emitter of Q211 through the network consisting of R239, 240, 241 and C216 to the base of Q208.

Compression is provided by coupling the audio output from the emitter of Q211 to a voltage doubler consisting of C221, CR213, CR214, and C220. The output of this doubler appears at the cathode of CR213 as a positive voltage which is proportional to the audio voltage output of Q211.

The positive output of the voltage doubler is applied to the base of dc amplifier Q212. The emitter of Q212 is coupled to the base of Q207.

Q207 is the stage that does the compression. It is shunted directly across the input of the compression amplifier. While there is no dc collector current path for Q207 it functions as a variable impedance in the input circuit. When the output of the compression amplifier starts to increase, the dc voltage at the output of CR213 becomes more positive. This positive voltage is amplified by Q212 and appears as a positive going voltage at its emitter. This positive going voltage causes the base of Q207 to become more forward biased and consequently Q207 becomes a lower impedance and reduces the gain of the compression amplifier.

A 30 db increase at any of the audio inputs to the T1360 (once the point of compression is reached) results in less than a 3 db change in output.

b. Receiver Amplifier and Switch

Audio from the base station is fed from the line transformer to the line input control R224. This audio is coupled from the arm of the pot to the base of the receiver amplifier Q203.

Q203 is a conventional type of amplifier except that it's emitter returns to ground through R215, R216, and receiver amplifier switch Q204.

A positive voltage is applied to the base of NPN transistor Q204 through CR206, R226, and R225. This voltage biases Q204 into saturation and grounds the emitter circuit of Q203 and the base of audio gate Q205. In this condition Q203 is properly biased and functions as an amplifier. Q205 is biased to cut off and appears as an open circuit to ground at the output of Q203 and audio is passed to the compression amplifier.

When either the microphone push-to-talk button or the desk set push-to-talk button are operated a ground is placed on the anode of CR206. This removes the positive voltage from the base of Q204 and Q204 cuts off.

When Q204 cuts off its collector swings in a positive direction. This positive voltage is applied to the emitter of Q203 causing it to cut off and no longer function as an amplifier. In addition the positive voltage at the collector of Q204 is applied to the base of Q205 causing it to go into saturation. This places a ground on the output of the receiver amplifier. As a result of these two actions no audio from the receiver path can be fed to the compression amplifier.

c. Microphone Input and Bias Switch

A transistorized microphone is used with the T1360 remote console. This means that a dc voltage must be fed out on the same line that is used for the audio.

The "hi" side of the microphone audio is connected to terminal number 5 of TB1 (screw terminals) on the audio board. The audio is fed through a blocking capacitor C211 and resistor R230 to the microphone input control. This control is tied to the compression amplifier input to complete the audio path.

Current to operate the microphone is supplied to terminal 5 through R229 and the collector of Q206. The base of Q206 normally has a positive voltage on it supplied through CR210 and R259. The positive voltage on its base causes Q206 to be in saturation and its collector will be at ground potential. With the collector of Q206 at ground potential there is no voltage present at terminal 5 to activate the microphone.

When the microphone Push-to-Talk switch is operated a ground is placed on the anode of CR210 through CR209 and R227. This removes the positive voltage from the base of Q206, and Q206 cuts off.

When Q206 cuts off its collector goes positive. This positive voltage is applied through R229 to terminal 5 on TB1. This positive voltage then activates the microphone so that audio can be fed to the compression amplifier.

d. Five Watt Output Amplifier and Switch

Audio from the compression amplifier is fed to the driver transistor through the "3 ohm set" potentiometer R256. This potentiometer is used to set the output level to 5 watts when the compression amplifier is in full compression.

The output of the "3 ohm set" potentiometer is fed to the base of the NPN driver transistor Q213. The driver transistor is a conventional amplifier with its emitter circuit returning to ground through the "5 watt amplifier switch" Q214.

Q214 normally has a positive voltage at its base supplied through R259 and CR215. This causes Q214 to be in saturation and its collector to be at ground potential.

With Q214 in saturation the driver transistor Q213 will be biased as an amplifier and its output is transformer coupled to the push-pull output stage.

The push-pull output stage consists of Q103 and Q104. Negative feedback is used to stabilize this stage. C102 and R103 from the collector to the base of Q103, and C103 and R104 from the collector to the base of Q104 supply part of the negative feedback. The rest is supplied from the collector of Q104 through R262 and C223 to the emitter of the driver transistor Q213.

The output of Q103 and Q104 is transformer coupled to the speaker. A pad type of level control is incorporated in the speaker path to set the speaker volume for the desired level. This pad control is located on the front panel.

When the microphone push-to-talk button is operated, a ground is placed on the base of the switch transistor Q214. This causes Q214 to cut off and its collector swings in a positive direction. The positive voltage at the collector of Q214 appears at the emitter of Q213 and biases Q213 into cut off.

When Q213 is cut off, no audio can reach the speaker.

When the transmitter is keyed by means of the Desk Set, push-to-talk switch diode CR208 prevents the ground thus supplied from appearing at the base of the 5 watt amplifier switch and any audio from the Desk Set Microphone is heard in the speaker. This provides the built-in "Dispatcher Monitor" feature.

e. Transmit Amplifier and Switch

Audio from the Compression Amplifier is connected to the "Line Output" potentiometer. The center arm of the potentiometer is connected to the base of Q215. Q215 and Q216 together form a driver-splitter to feed the push-pull output stage.

The audio fed to the base of Q215 is amplified and the output from the collector is direct coupled to the base of Q217 (one of the output transistors).

The output from the collector of Q215 is also coupled through C227, and an attenuator made up of R265 and C228 to the base of Q216. The amplified signal at the collector of Q216 is direct coupled to the base of Q218. This signal is of the proper phase and amplitude to provide the push-pull drive to the Line Output Amplifier consisting of Q217 and Q218.

Q217 and Q218 are a conventional push-pull output stage transformer coupled to the line by means of T105, the Line Output Transformer. This output stage is capable of +18 DBM output.

The emitters of both Q217 and Q218 are returned to ground through the transmit amplifier switch Q219.

The base of the transmit amplifier switch (Q219) is normally returned to ground through the receiver amplifier switch Q204. With a ground potential applied to the base of Q219, it is cut off and its collector is positive. The positive voltage at the collector of Q219 is coupled to the emitters of Q217 and Q218 through R273 and R274. A positive voltage on the emitters of Q217 and Q218 cause them to be cut off and no audio is fed to the Line Transformer T105.

When the transmitter is keyed from either the microphone or the desk set, the receiver amplifier switch Q204 is cut off and its collector goes positive. The positive voltage from the collector of Q204 is coupled to the base of Q219, the transmit amplifier switch.

A positive voltage on the base of Q219 causes it to go into saturation and apply a ground to the emitter circuits of Q217 and Q218.

This action biases Q217 and Q218 for normal amplification and the audio from the microphone or desk set is fed to the line through the Line Transformer T105.

The diode network across the collectors of Q217 and Q218 is a surge protection circuit.

Diodes CR216, 217, 218 and 219 are set up so that no matter what polarity signal or surge that appears on the line the junction of CR216 and CR218 is negative and the junction of CR217 and CR219 is positive.

A silicon control rectifier CR220 is connected with its cathode to the negative junction and its anode connected to the positive junction. The trigger lead of the SCR is connected to the positive junction through a zener diode.

Below the firing point of the zener the diode network appears as an open circuit. When a surge or voltage spike exceeding the firing point of the zener diode appears across the line, the zener diode conducts and triggers the silicon controlled rectifier (SCR). Conduction of the SCR completes the path through the other diodes and effectively places a short circuit across the line for the duration of the surge. When current through the SCR drops below the holding value, it goes out of conduction and the diode network again appears as an open circuit across the line.

2. CURRENT BOARD

The Current Board is shown in Figure 17. There are two Line Current Regulators used, a positive and a negative. Only the positive one will be explained as they are both identical. The only difference being the connections to the line are reversed.

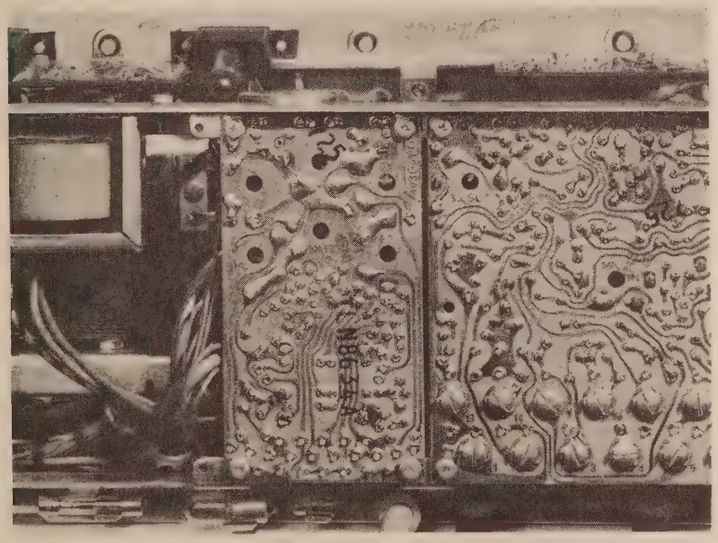


Figure 17. Current Board

a. AC Operation

Power for the primary of T102 is supplied from the secondary of the power transformer T101 through diodes CR303 and CR304. The cathodes of the diodes are tied to the primary of T102. With the diodes connected in this manner there is no current path in the primary of T102 and therefore no voltage appears at the secondary. When the center tap of T102's primary is grounded, however, there is a current path in the primary. This path is alternately through CR303 or CR304 back to the grounded center taps on T101 and T102 as the polarity of the ac line switches back and forth.

When the center tap of T102 is grounded, the current in the primary will produce a high voltage across the secondary terminals to provide the line currents to control the base station.

The ground for the center tap of T102 is supplied by the Push-to-Talk Switch Circuits and the ground for the negative line kit is provided by either the "PL Monitor" or the "Mute Receiver 2 Switch".

The Push-to-Talk Switch circuit consists of transistors Q301 and Q302.

The base of Q301 is connected through R301 to the collector of the receiver amplifier switch Q204. In the receive mode of operation the collector of Q204 is at ground potential placing a ground on the base of Q301.

When the base of Q301 is at ground potential, it is cut off and its emitter is at ground potential. This places a ground on the base of Q302 causing it to be cut off. Q302 provides the ground path for the center tap of T102's primary.

When either the Microphone or the Desk Set Push-to-Talk Switch is operated, the receiver amplifier switch Q204 is cut off and its collector goes positive providing a positive voltage to the base of Q301.

The positive voltage on the base of Q301 causes it to conduct and its emitter swings in a positive direction. This drives Q302 into saturation and provides a ground for the center tap of T102.

b. DC Operation

The model with the 12 Volt Emergency Operation utilizes a DC to DC converter, instead of a transformer only, to develop the high voltage required for the line currents.

The converter consists of three transistors Q401, 402 and 403 plus a special transformer T401. This converter replaces the AC transformer. The lead marked A is connected to the Push-to-Talk Switch circuit. Leads E and F are the high voltage output leads. The lead marked 1 ties to plus 13.8 volts.

Q401 and Q402 have their emitters grounded. A positive voltage is tied to the collectors of Q401 and Q402 through the primary of T401. The bases of both transistors are connected opposite ends of the feedback winding.

The center tap of the feedback winding is tied to the plus voltage through transistor Q403. When neither the microphone or desk set push-to-talk switches are operated, the base of Q403 is positive and Q403 is cut off. When Q403 is cut off, the feedback path of the converter is broken and the converter is inoperative.

If either the Microphone or Desk Set Push-to-Talk Switch is operated, a ground is placed on the base of Q403 through Q302. This causes Q403 to become saturated and complete the feedback path for the converter.

When Q403 conducts, a positive voltage is placed on the bases of both Q401 and Q402. One or the other of these transistors will conduct more than the other. Assume Q401 conducts more heavily.

The current flowing in the Q401 half of T401's primary will induce a voltage in the feedback winding. This feedback voltage will be of the proper polarity to cause Q401 to go to saturation and Q402 to cut off.

When current no longer increases in the Q401 leg of the primary, the polarity of the feedback winding reverses and Q401 is now driven to cut off and Q402 to saturation.

This action will continue switching back and forth as long as Q403 is held in conduction. When the Push-to-Talk Switch is released, Q403 is cut off, opening up the feedback path and the converter quits oscillating.

As long as the converter is oscillating, a high voltage is developed at its output and fed to the current regulator. When the oscillations stop, the high voltage disappears; and no control current is present.

c. Current Regulator

The high voltage output of transformer or converter just described is fed to a full-wave bridge rectifier consisting of diodes CR309, 310, 311 and 312. Capacitor C302 is tied between the positive and negative terminals and is used to filter the output. The negative side is completely isolated from chassis ground so that the line output of the T1360 is balanced and has minimum hum.

The positive output from the bridge rectifier is coupled through diode CR314 to one side of the line. The negative side of the bridge rectifier goes to the actual current regulator and from there to the other side of the line.

The current regulation is done by transistor Q102.

The base of Q102 has a fixed reference voltage applied to it. This reference voltage is established by resistor R305, zener diode CR316 and diode CR318.

The negative side of the bridge rectifier ties through either R309 or R310 potentiometer (depending on the position of the "F1-F2" switch) to the emitter of Q102. The collector of Q102 is tied to the negative side of the line.

The emitter voltage of Q102 depends on the current through the potentiometer. With no current drawn through the potentiometer, the emitter of Q102 is negative with respect to its base and Q102 is a very low resistance. When a load is placed across the line, current is drawn through the potentiometer. This current causes a voltage drop across the potentiometer. The voltage drop across the potentiometer causes the emitter of Q102 to shift in a positive direction and reduce the forward bias. As the forward bias is reduced, Q102 becomes a higher resistance.

By adjusting the potentiometer, the line current can be set to a specific value, 11.5 ma for example. Once the current is set to 11.5 ma, if the current tries to increase, the voltage drop across the potentiometer increases further reducing the forward bias on Q102. Q102 becomes a higher resistance and holds the current to the set value.

If the current tends to decrease, the voltage drop across the potentiometer decreases. When the voltage drop decreases, this increases the forward bias on Q102 making it a lower resistance and holds the current at the set value.

3. POWER SUPPLY

The normal power supply is operated from the 117 volt AC line and is a regulated supply. For emergency use a 12 volt battery such as a car battery can be used.

a. AC Operation

The 117 volt AC line is connected to the power transformer T101 primary through S101 the on-off switch. T101 is a step-down transformer. The secondary of T101 is connected to a full-wave rectifier consisting of CR201 and CR202. The DC output is filtered by C101 and fed to the series regulator transistor (Q101) collector. The positive output for the rest of the unit is taken from the emitter of Q101. Transistors Q201 and Q202 are DC amplifiers used to improve the regulation.

The emitter of Q202 is held at a fixed reference voltage by zener diode CR203. The base voltage of Q202 is determined by the voltage divider consisting of R204, R205 and R206 from the positive output to ground.

As the positive voltage tends to go up, the base of Q202 goes more positive. Its collector shifts in a negative direction. This negative voltage appears at the base of Q201 and causes its emitter to shift in a negative direction. The negative going emitter voltage is coupled to the base of the series regulator transistor Q101 causing it to become a higher resistance and hold the output voltage constant.

R306 in the voltage divider for the base of Q202 is a potentiometer. Potentiometer R306 is used to set the output voltage at 13.8 volts. If the positive output voltage tends to decrease, the base of Q202 shifts in a negative direction.

This causes the collector of Q202 to shift in a positive direction. This positive going voltage appears on the base of Q201 causing its emitter and the base of Q101 to shift in a positive direction.

The base of Q101 going in a positive direction causes it to become a lower resistance and maintain a constant output voltage.

The output of the regulator is fed to a series of isolated positive outputs 1, 2, 3, and 4.

b. DC Operation

For DC operation the 13.8 volt output line of the regulator is broken and the line from the 12 volt battery input is tied to the positive outputs 1, 2, 3, and 4. Diode CR205 is used for reverse polarity protection.

4. ACCESSORIES

Accessories are easily installed. All that is required to install them (once the switches have been mounted) is to clip the proper jumper and plug the numbered wires to the appropriate pin as shown in Figures 18 and 19.

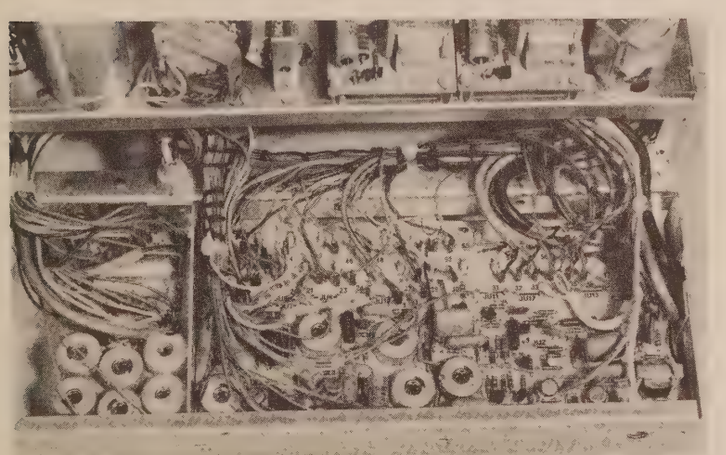


Figure 18. Back of Amplifier Board

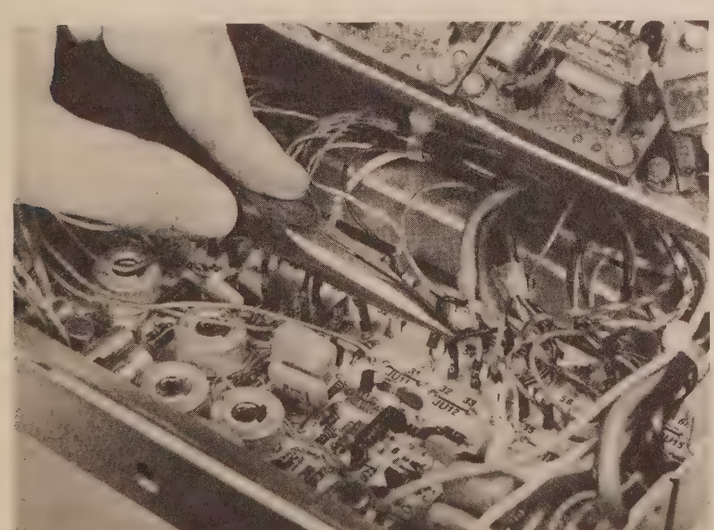


Figure 19. Plugging in an Accessory Lead

a. TLN8635A and TLN8636A Clock Kit

The clock kit is available as a 12 or a 24 hour clock. It connects across the AC line before the on-off switch so that the clock will continue to run even if the switch is in the off position.

b. TLN8647A "Private-Line" Switch Kit

The "PL" monitor switch puts a ground on the primary of the negative line current supply turning it on. R306 in the current regulator is adjusted for the appropriate line current.

c. TLN8645A Mute Receiver 2 Kit

One set of contacts in the Mute Receiver 2 Kit places a ground on the primary of the negative line current supply to turn it on. Another set of contacts breaks the lead to the PL adjustment R106 and connects R107 into the regulator circuit. R107 is adjusted to the proper current for muting receiver number 2.

d. TLN8646A F1-F2 Switch Kit

The Two Frequency Switch is a locking type of switch. Its contacts connect either R309 or R310 (depending on the position of the switch) into the positive current regulator. These resistors are adjusted to set the proper current value for F1 and F2 operation respectively.

e. TLN8641A Transmitter Switch Kit

The Transmitter Switch Kit simply places a ground on the microphone push-to-talk line and keys the system in the same manner as the microphone.

f. TLN8650A Intercom Switch Kit

When the Intercom Switch is operated, one set of contacts applies a ground to the same line that the desk set push-to-talk switch does. However, the ground from the intercom switch is applied to the opposite end of R226. R226 prevents the transmit light from being lit by the intercom switch.

The ground from the intercom switch keys the system in exactly the same manner as the desk set push-to-talk switch.

To prevent the transmitter from being keyed by the intercom switch a normally closed set of contacts are inserted in the line to the base of the Push-to-Talk Switch (Q301) transistor. When the intercom switch is operated, these contacts open and the transmitter can not be keyed.

To prevent audio feedback from the speaker a set of contacts in series with one side of the output transformer secondary is opened when the intercom switch is operated.

g. TLN8640A Speaker Mute Kit

One side of the speaker lead is routed through a normally closed set of contacts on the Speaker Mute Switch.

When the switch is operated, this path is broken and an attenuator consisting of R901 and potentiometer R902 is inserted in series with the speaker.

Potentiometer R902 allows the speaker output to be reduced to a preset level when the speaker mute switch is operated.

h. TLN8649A Alternate Line Kit

An Alternate Line Kit permits the same T1360 Remote Console to be used with two completely separate transmitters, one at a time. This is for two wire operation. The control line current regulators make this type of operation possible. With control line current regulation, even if the DC resistance of the two systems is different, the same control currents are applied to whichever system is selected.

When this kit is used, the two wire output line from the line transformer is broken and fed to the center arms of two sets of contacts on the Alternate Line Switch. When the switch is in Line 1 position, the contacts connect the output of the line transformer to terminals 11 and 12 on TB1. When the switch is in the Line 2 position, the output of the line transformer is connected to terminals 24 and 25 of TB1.

This allows the operator to select the desired system.

i. TLN8648A Supervisory Switch Kit

When the Supervisory Switch Kit is used, the lines from the parallel remotes are connected to terminals 22 and 23 of TB1. From this point the lines go through normally closed contacts on the supervisory switch and are connected in parallel to the line output transformer.

When the Supervisory Switch is placed in the "take-over" position, these switch contacts are opened; and the transmitter cannot be keyed from one of the other remotes.

Also, to prevent the transmitter from being keyed by a Desk Set tied into the console a set of normally closed contacts is inserted in the desk set Push-to-Talk line. When the Supervisory Switch is in the "take-over" position, these contacts are also broken.

Thus in the "take-over" position of the supervisory switch the only way the transmitter can be keyed is with the Microphone Push-to-Talk Switch.

j. TLN8644A Line Compensation Kit

In instances where line compensation is needed this Line Compensation Kit can be installed in the receive side of the circuit.

It is a LC circuit with a series resistor. This is tied to the base circuit of the receiver amplifier.

The amount of compensation applied is determined by the value of the series resistor. In order to set for the proper amount of compensation a jumper lead that can be plugged into eleven different positions is used. In one of these positions the compensation network is disconnected entirely. The other ten positions give varying degrees of compensation.

k. TLN8652A Line Operated Transmit Light Kit

When more than one remote console is used it is necessary to use the Line Operated Transmit Light Kit to have the transmit light turn on when the system is keyed from another remote console.

This is accomplished by removing the transmit light from the push-to-talk circuit and operating it from a line sampling circuit. Whenever there is a keying voltage present across the control line (from any source), the transmit light is turned on.

The line operated transmit light kit has its own separate isolated power supply so that it does not upset the balanced line. This power supply consists of a transformer, a half-wave rectifier, and filter capacitors.

Transformer T601's primary is connected across the 117 volt AC line. The secondary goes to diode CR601 to provide the half-wave rectification. Capacitors C601 and C602 provide the filtering.

The actual light operating circuit consists of two DC amplifiers Q601 and Q602 which operate Q603, a switch transistor.

The positive side of the control line is tied to the emitter circuit of Q601, and the negative side of the control line is tied to the base of Q601 through R601. R601 provides isolation from the control line circuit as well as performing the function of a voltage divider in conjunction with R602 for the base of Q601.

When a keying voltage is present on the control line, the negative voltage appearing on the base of PNP transistor Q106 causes it to conduct and its emitter swings in the negative direction. Its emitter is coupled through R604 to the base of PNP transistor Q602.

This negative voltage on the base of Q602 causes its collector to shift in a positive direction. This positive voltage is coupled to the base of NPN transistor Q603 through R606. The emitter of Q603 has a fixed bias voltage from the voltage divider consisting of R608 and CR602. When the base of Q603 is driven more positive than this fixed emitter bias, Q603 is driven into saturation. The transmit light DS102 is in the collector circuit of Q603, and when Q603 is driven into saturation, the transmitter light is turned on.

When no keying voltage is present on the control lines, no negative voltage appears on the base of Q601; consequently, its emitter is at its most positive potential. This positive voltage appears on the base of Q602 and causes it to conduct less heavily. When Q602 conducts less heavily its collector swings in a negative direction. This negative going voltage appearing at the base of Q603 causes it to cut off and the transmit light is turned off.

l. TLN8639A Alert Tone Kit

The Alert Tone Kit is used to key the transmitter and send a 1000 cycle audio tone for test purposes or as an alert signal.

The Alert Tone Kit consists of a switch and a phase shift oscillator. When the alert tone switch is operated, one set of contacts applies the ground to the microphone push-to-talk line. This keys the transmitter the same as if the Microphone Push-to-Talk Switch were actuated.

At the same time another set of contacts applies voltage to the phase shift oscillator transistor Q501.

Transistor Q501 is biased the same as a normal amplifier. Its base bias is determined by a voltage divider made up of R503, R504, and R505. The output from its collector is coupled in two paths. One path provides the feedback for the oscillator. The collector output is coupled through a three section phase shift network consisting of C502, C503, C505, R507, R509 and R505 back to the base of Q501. This phase shift network has a 180^{o} phase shift at 1000 cycles. This provides an in-phase signal to the base of Q501 causing it to oscillate. The frequency of oscillation is determined by the RC time constant of the phase shift network. The other path feeds the audio output through R508 to the input of the compression amplifier. When the black insulated jumper is in place, the output of the alert tone oscillator is sufficient to drive the compression amplifier into full compression.

m. TLN8643A VU Meter Kit

The VU Meter Kit provides a visual indication of the audio level. It consists of a transistor amplifier and a panel mounted meter.

The audio output of the compression amplifier is coupled through C702 to the center arm of the potentiometer R704. Audio is coupled from one end of R704 to the base of Q701. Q701 is a conventional amplifier. The amplified audio appearing at its collector is coupled through C703 to a bridge rectifier circuit consisting of CR701, CR702, CR703 and CR704. R708 and R709 form a combination voltage divider and load across the output of the bridge rectifier. Meter M701 is connected across the voltage divider.

When an audio signal appears at the output of the compression amplifier, it is amplified by Q701; and the bridge rectifier gives a DC output voltage proportional to the audio level. Potentiometer R704 is used to calibrate the meter reading to the proper value.

III. T1375 REMOTE DESK SET

A. DESCRIPTION

The T1375 series Remote Desk Set shown in Figure 20 is a complete self-contained remote control. This unit contains a Compression Amplifier, a Line Output Amplifier and a separate Speaker Amplifier. It also contains a Line Current Section and is completely transistorized. There are two versions available; one is a 117 volt AC operated unit and the other is a 117 volt AC, 12 volt DC operated unit.

Figure 20. T1375 Remote Desk Set

Figures 21 and 22 show the housing removed and circuit boards exposed.

Both units are very compact and are housed in a standard telephone size desk set. The Level Setting Controls are available on the bottom side of the unit (see Figure 23).

1. FEATURES

Transistors are used for all of the audio circuits and control functions, increasing the reliability of the unit.

All switching functions are performed by transistors. This eliminates the need for any relay maintenance.

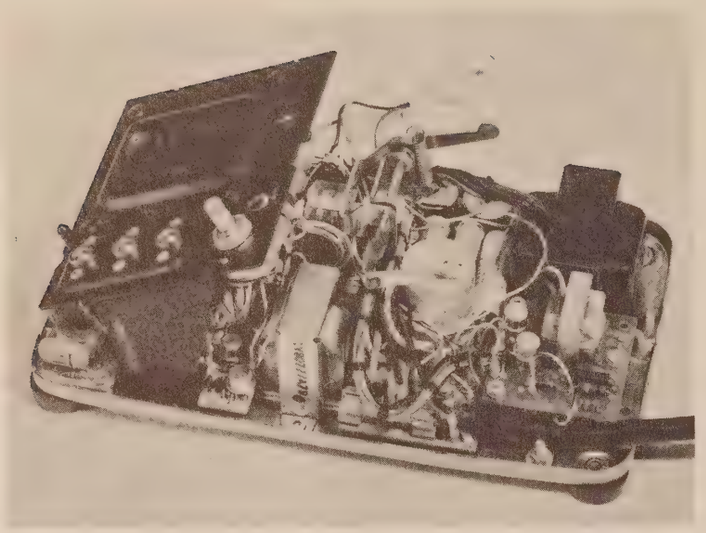


Figure 21. T1375 Housing Removed

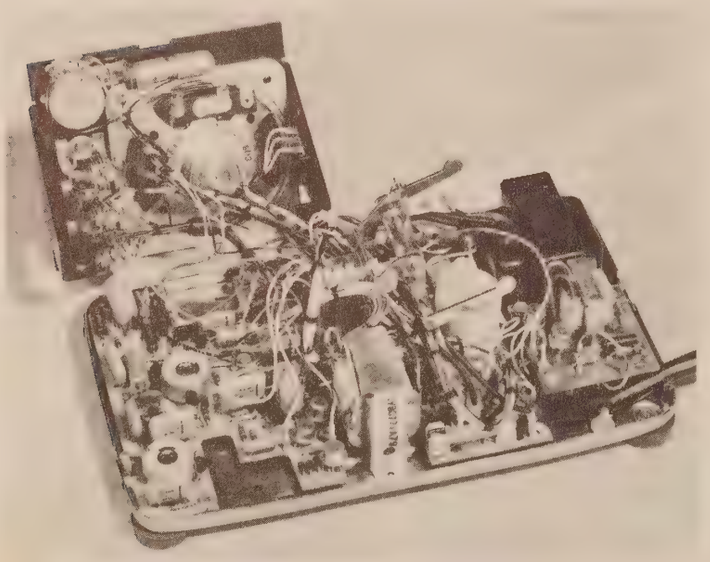


Figure 22. T1375 Circuit Board Exposed

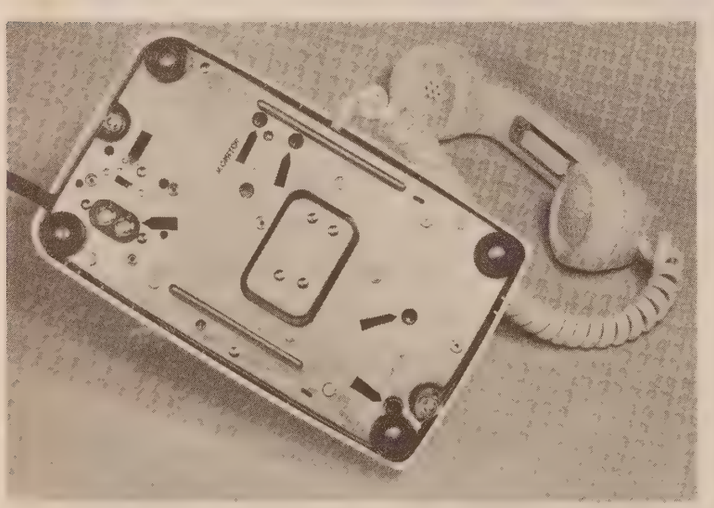


Figure 23. T1375 Bottom View

The compression level is fixed and requires no adjustment of the compression amplifier.

The audio from the compression amplifier is fed to two completely separate amplifiers. One Output Amplifier has an output of +18 dbm with less than 3% distortion. It has an Output Level Control and a Line Matching Transformer to feed the telephone lines.

The Second Audio Output is rated at 500 milliwatts at less than 5% distortion and is used to feed the Desk Set speaker or hand set earpiece.

These distortion figures are based on the compression amplifier being 30 db into compression.

The DC line current portion provides line current to control the various functions. These line currents are not regulated.

The DC line current supplies are isolated from chassis ground to maintain a balanced output and reduce hum.

For emergency operation the remote desk set can be operated from a 12 volt DC battery source.

2. OPTIONS

There are three options available to make the T1375 series Remote Desk Sets more versatile. These options are as follows:

a. Two-Frequency Control option — a two frequency control switch provides F1-F2 selection from the remote control site.

b. Private Line Monitor option — this switch disables the "Private-Line" tone-coded squelch to allow monitoring of the channel before transmitting.

c. Intercom option — this option provides two way intercommunication between other remote control points and the base station.

B. THEORY OF OPERATION

The operation of the Remote Desk Set can best be understood by going through the functions in block form.

1. BLOCK DIAGRAM

A block diagram shown in Figure 24 shows the T1375 series Remote Desk Set broken into six major sections. These sections are as follows:

The Input Section, the Compression Section, the Line Output Section, the Local Audio Section, the Intercom Section, and the DC Current Section.

a. Input Section

The input section has two audio inputs. These are the Handset Microphone and a Receiver Input from the line transformer.

b. Compression Amplifier

The two audio inputs are combined and fed to the Compression Amplifier. The compression amplifier is identical to the compression amplifier used in the T1360 series remote console.

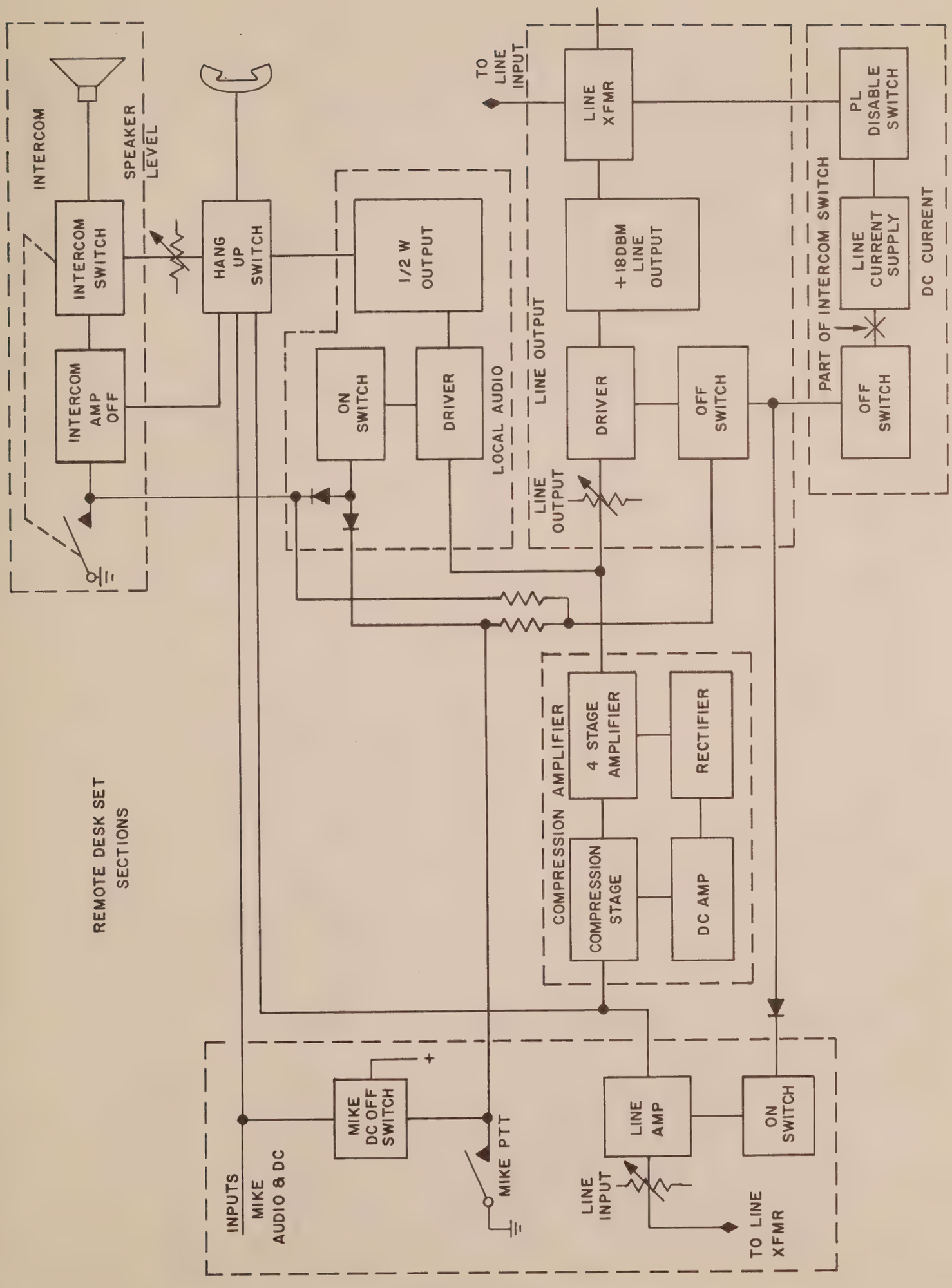


Figure 24. T1375 Block Showing Sections

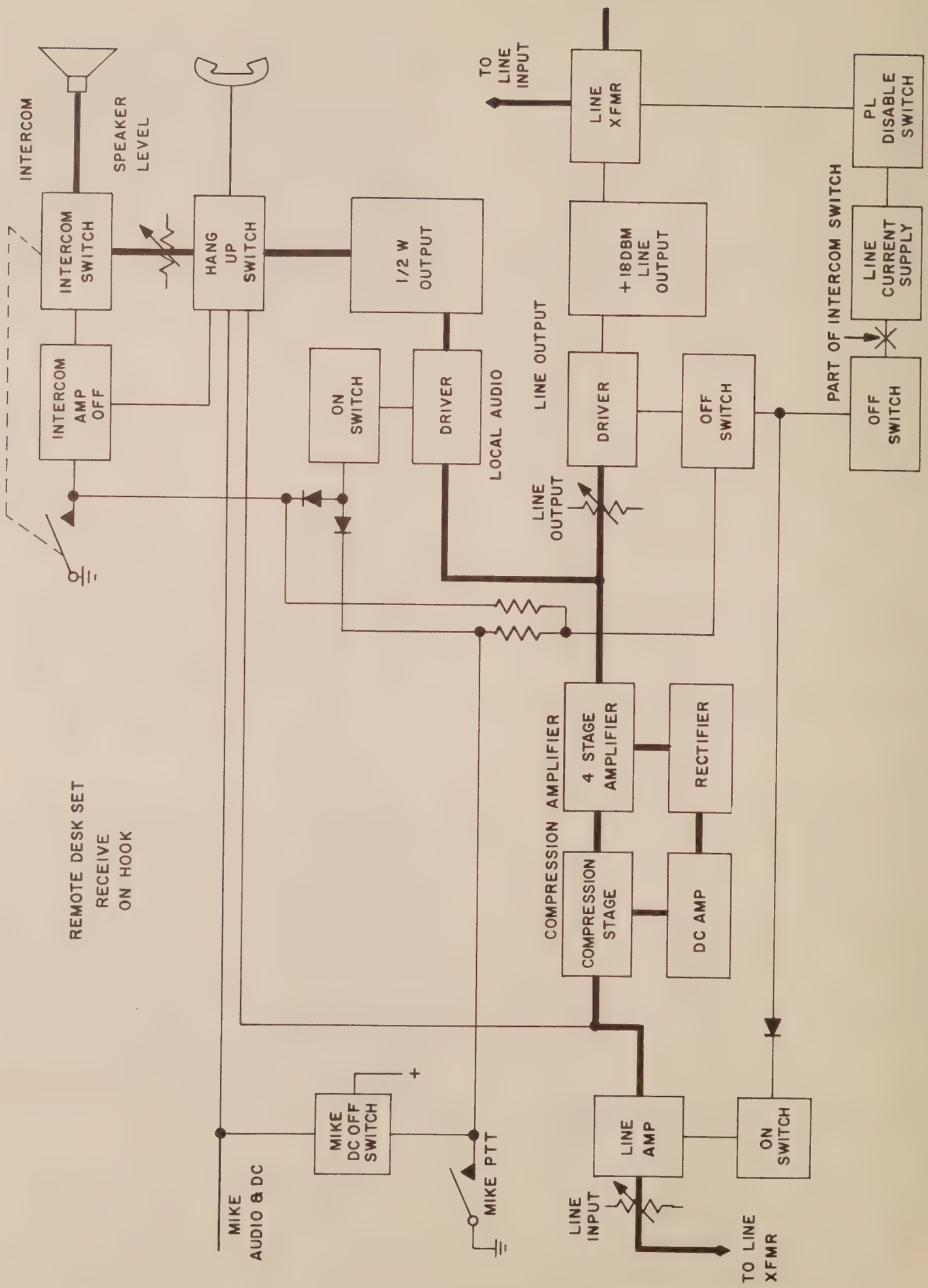


Figure 25. T1375 Block Receive Mode (on hook)

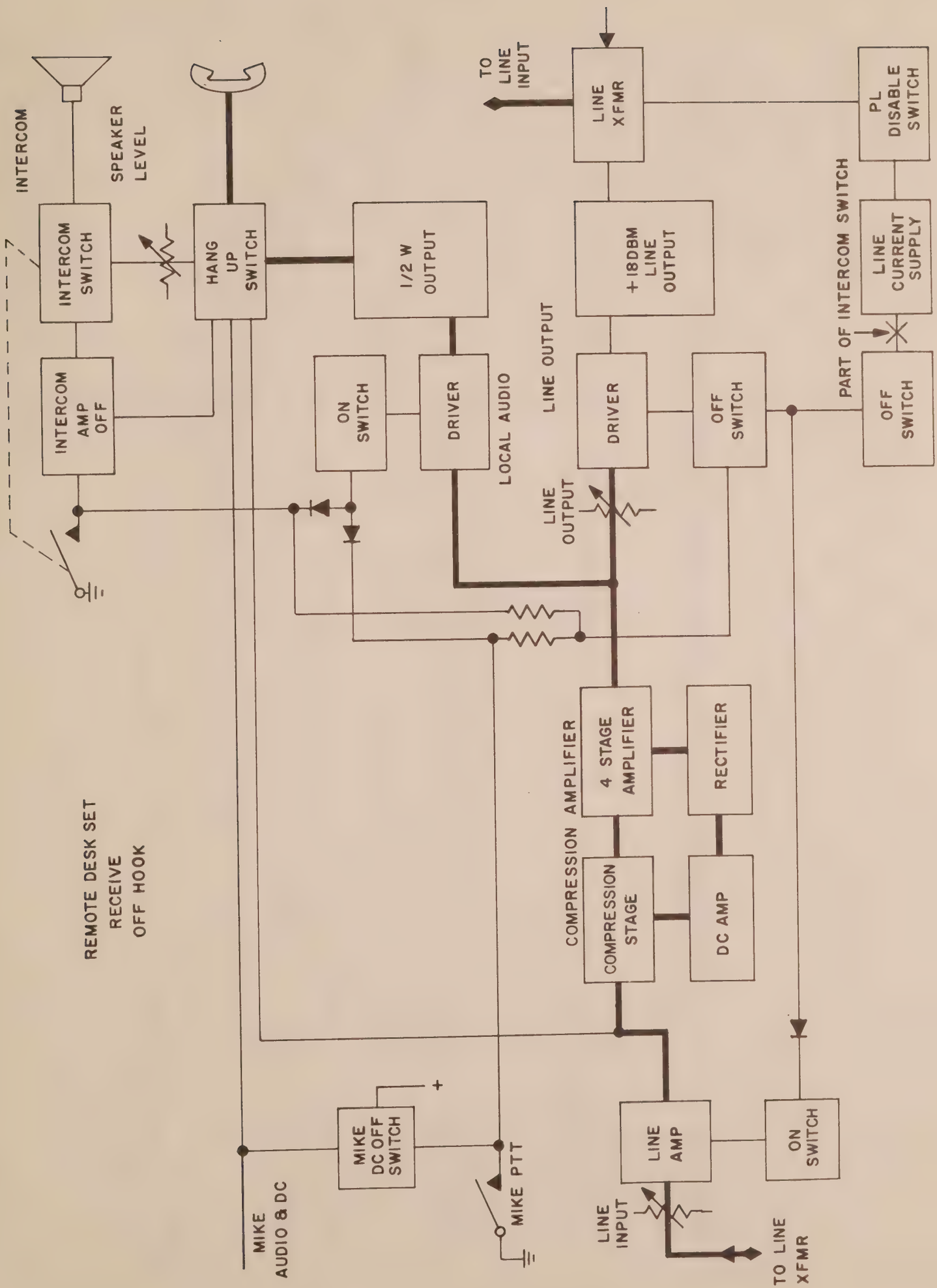


Figure 26. T1375 Block Receive Mode (off hook)

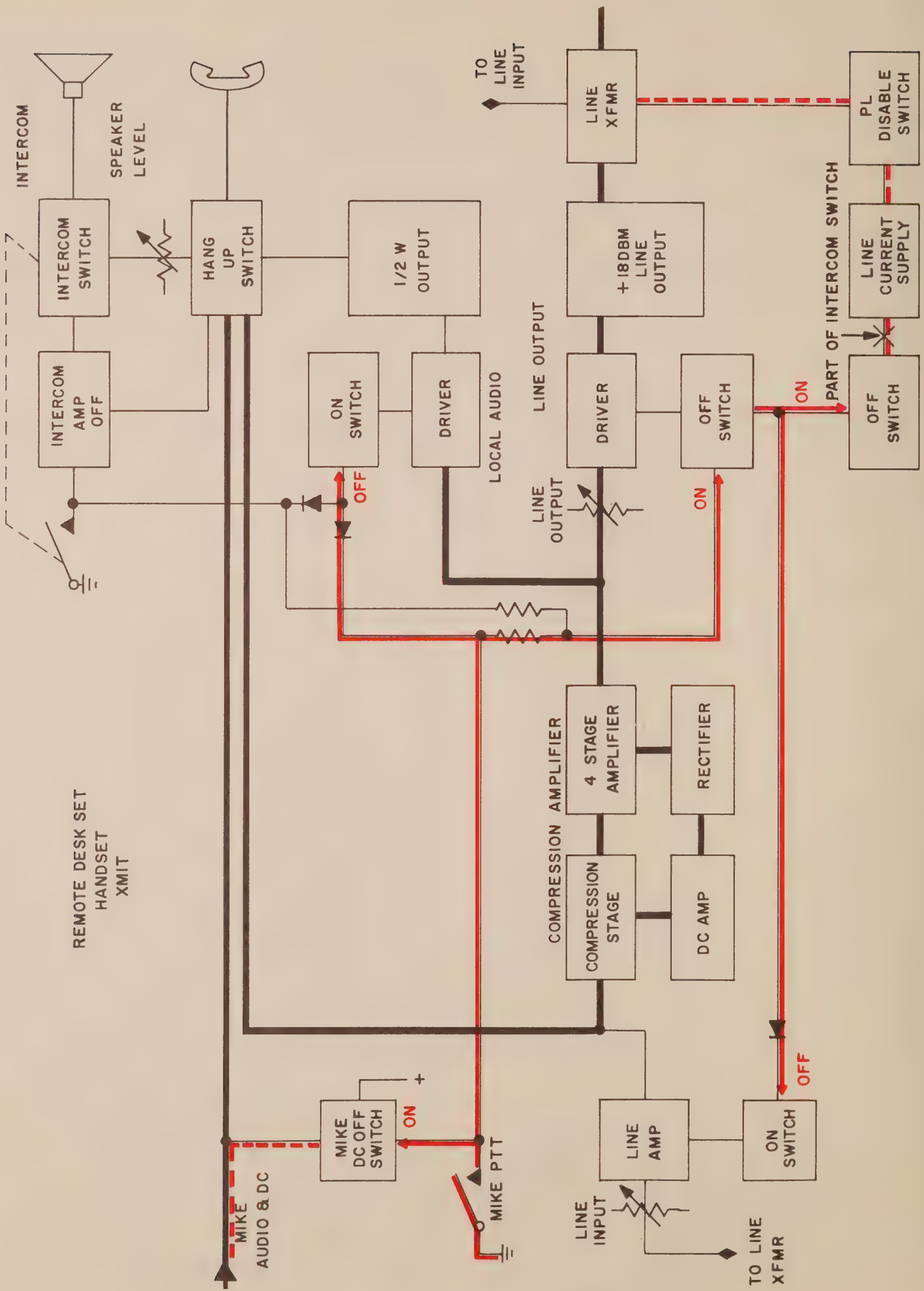


Figure 27. T1375 Block Transmit

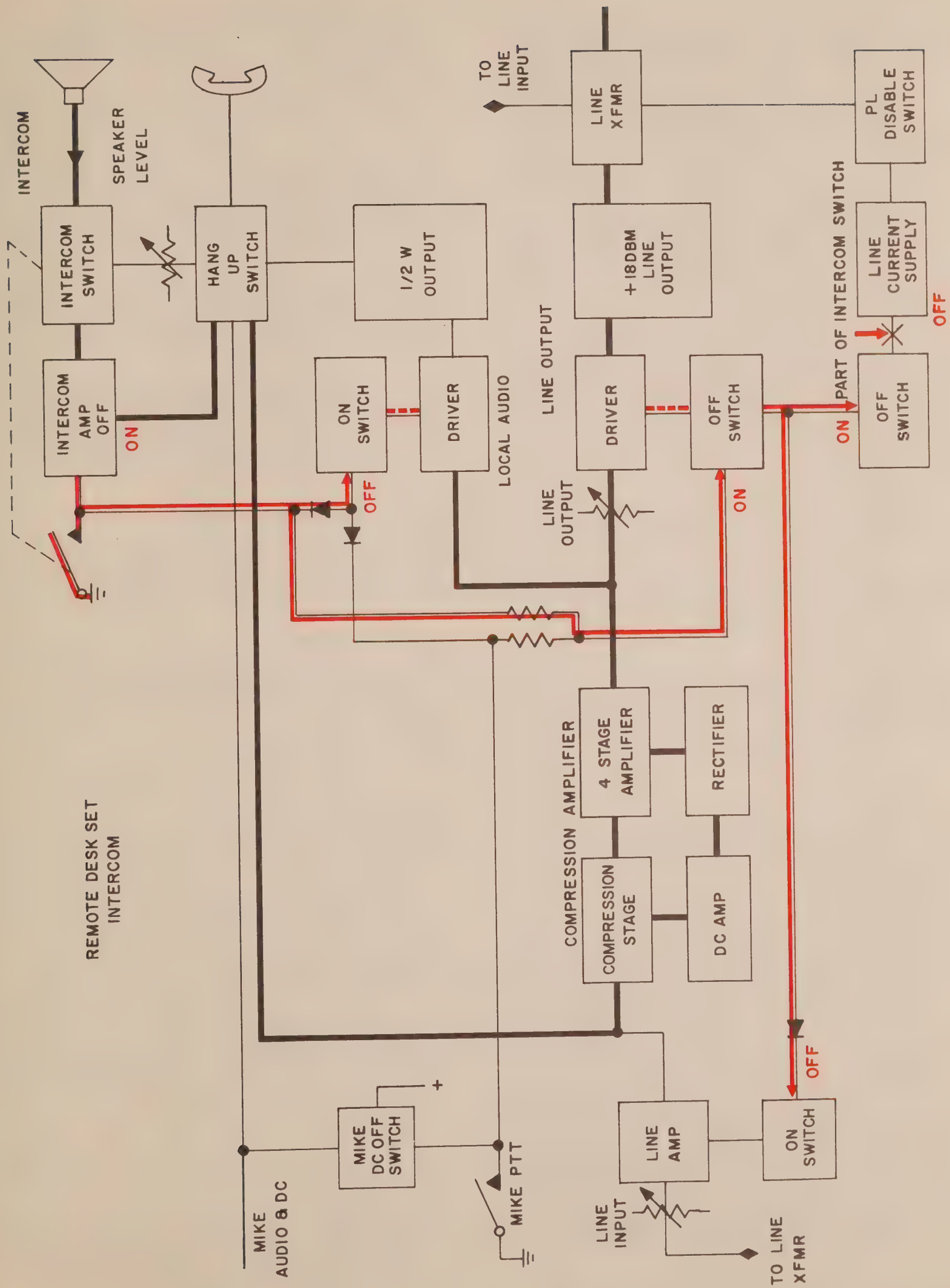


Figure 28. T1375 Block Intercom

c. Line Output Amplifier

The output of the compression amplifier feeds through a Level Control to the driver stage. The driver amplifies the audio and feeds the push-pull line output stage. This stage is capable of an output level of plus 18 dbm. Audio from the line output amplifier is coupled to the telephone line by means of the line transformer.

d. Local Audio

Audio from the Compression Amplifier is also fed to the driver stage of the local audio section. The driver stage feeds the half watt output amplifier.

The half watt output is fed through the Hang-up Switch (when the handset is hung up), through a Speaker Level Control, through the Intercom Switch to the speaker. When the handset is off hook, the audio is routed to the handset earpiece.

e. Intercom

For Intercom operation operating the Intercom Switch converts the speaker to a microphone by connecting the speaker leads to the intercom amplifier. The audio from the speaker is then routed through the compression amplifier and line output amplifier to the telephone line.

f. DC Current

Control currents for turning on the transmitter and other functions, are generated in the DC current section. The Line Current Supply is a completely separate power supply. The output is isolated from the ground to minimize hum.

The PL Disable Switch reverses the polarity of the currents for disabling the PL of the transmitter and turns on the current supply.

2. OPERATION

Operation of the T1365 series remote desk set can be separated into four modes. These modes are: Receive (handset on hook), Receive (handset off hook), Transmit, and Intercom.

Each of these modes is shown in a separate block diagram. The heavy solid line indicates the audio path and the red lines indicate the control and switching paths in each block diagram.

a. Receive Mode (on hook)

Refer to Figure 25 for the receive mode of operation. In this mode of operation neither the push-to-talk switch or the intercom switch are operated, and the various switches are in the condition indicated in their individual boxes.

The receive audio from the telephone line is connected from the line transformer through the line input control to the line amplifier. Since the line amplifier switch is in the on condition, the receiver audio is amplified and passed on to the input to the compression amplifier.

The output of the compression amplifier connects to both audio output stages.

The audio path to the line amplifier passes through a "line output control" to the driver stage of the +18 dbm output section. The switch in the driver stage is off and no audio is fed past this point.

Audio is also coupled to the driver stage of the half watt local output section. The driver stage switch is in the on condition so the audio is amplified by the driver and fed to the output stage.

From the output stage the audio passes through the hang-up switch and the speaker level control to the intercom switch. Since the intercom switch is not actuated at this time, the audio is passed through the intercom switch and is heard at the speaker.

b. Receive Mode (off hook)

Refer to Figure 26 for the off-hook mode of operation. This mode of operation is identical to the on-hook mode up to the output of the half watt output stage.

With the handset off hook the hang-up switch contacts transfer the audio output from the speaker level control to the hand-set earphone.

c. Transmit Mode

The transmit mode of operation is shown in Figure 27. In this mode of operation the handset is off hook.

When the push-to-talk button is operated, a ground is placed on the control path, shown in red. This ground couples to the various switches and causes them to assume the condition shown in red beside the boxes.

The microphone DC switch is turned on supplying a DC voltage to activate the microphone in the handset. Audio from the microphone is fed through the hang-up switch (in the off hook condition) to the input of the compression amplifier. The output of the compression amplifier is connected to both the local audio section and the line output section.

The switch for the driver stage of the local audio section is turned off and no audio is fed to the handset.

Audio fed to the line output section passes through the line output control to the driver. The driver switch is now on and the audio is coupled to the output stage. From the output stage the audio is coupled to the line by the line transformer.

At the same time the audio is being fed to the line, the ground from the push-to-talk switch turns the Line Current Switch on. With the Line Current Switch in the on position, the Line Current Supply develops the proper DC control current. The control current is passed through the "PL" Disable Switch to the line transformer secondary.

The "PL" Disable Switch is used to turn on the line current supply and to reverse the polarity of the control current for the "Private-Line" monitor function.

d. Intercom Mode

The Intercom Switch, when operated, places a ground on the intercom amplifier and the control circuit as shown in Figure 28.

Operating the intercom switch also disconnects the speaker from the half watt audio section and connects it to the input of the intercom amplifier. This converts the speaker into a microphone for intercom operation.

As long as the intercom switch is operated, the intercom amplifier is turned on and audio from the speaker is amplified. This amplified audio goes to the hang-up switch. When the handset is on hook, the audio from the intercom amplifier is connected to the compression amplifier.

Audio from the compression amplifer fed to the half watt amplifier is cut off by the driver switch. The audio going to the line output section is fed through the line output control to the driver. The driver switch is turned on by the ground from the intercom switch, and the audio signal is amplified and fed to the +18 dbm output stage.

An output from the driver switch turns off the line input amplifier preventing audio appearing at the line transformer from being fed back to the input.

The DC current switch is also turned on by the output of the driver switch. No current is developed by the line current supply, however, because a set of contacts in the intercom switch break the path from the DC current switch to the line current supply.

Operation of the intercom, thus, converts the speaker to a microphone and causes the amplified audio to be applied to the telephone line without any control currents.

IV. LEVELS

Levels and the terms associated with them probably present the most confusing aspect of setting up and adjusting remote consoles, as well as other equipment using tone operated devices such as "Quik-Call", "Private-Line", "Single Tone", "Pager" and others.

The proper adjustment of levels is the key to trouble-free operation of this type of equipment.

To better understand the terms used in expressing audio levels, a brief review is in order of such expressions as Bels, Decibels, Power Levels, voltage and current ratios and Volume Units.

A. BELS, DECIBELS, AND POWER RATIOS

In audio or sound measurement the basic unit of comparison is the bel. Unlike the more common units of measurement such as voltage and current, the bel is used to express the power relationship between two sound levels rather than to indicate a specific power level. The bel represents a power ratio of 10 to 1 between the strength of two sounds.

As an example, consider three sounds of different power intensity. If the power intensity of the second sound is 10 times the power intensity of the first, its power level is said to be 1 bel above that of the first. If the third sound has a power intensity which is 10 times that of the second, its level is 1 bel above that of the second. But, since the third sound is 100 times as intense as the first, its level is 2 bels above that of the first. Thus, a power ratio of 100 to 1 is represented by 2 bels, a power ratio of 1000 to 1 by 3 bels, etc. Therefore, the concept of bels represents a logarithmic relationship, since the logarithm of 100 to the base 10 equals 2 (corresponding to 2 bels), the logarithm of 1000 equals 3 (corresponding to 3 bels), etc.

Since the bel is a rather large unit, its use is generally inconvenient. In fact its use in normal measurement would be similar to using miles instead of feet to measure the size of a room. Therefore, a smaller unit, the decibel, is generally used. A decibel is one tenth of a bel. Using the decibel a 10 to 1 power ratio is now represented by the term 10 decibels (10 db), a 100 to 1 ratio by 20 db, etc.

B. POWER LEVELS

It should be clearly understood that the term decibel does not in itself indicate power but rather a ratio or comparison between two power values. However, it is often desirable to express performance measurements in decibels. This can be done by using a fixed power level as a reference. The original standard reference level was 6 milliwatts, later a 1 milliwatt standard was adopted for general use. When 1 mw is used as a reference the level or ratio is expressed in dbm's. The conversion from power ratio to db or dbm levels can be made as follows:

$$db = 10 \log (P2/P1)$$

As an example, if the output of one amplifier is increased from 1 watt to 2 watts and the output of another amplifier is increased from 30 watts to 60 watts, the output of both amplifiers has been increased by 3 db.

$$\text{Since amplifier one increase is } 10 \log \frac{2}{1}$$

$$\text{then } 10 \log 2 = 3 \text{ db}$$

amplifier two increase is 10 log 60/30 which again is 10 log 2 = 3 db.

C. VOLTAGE AND CURRENT RATIOS

Voltage and current ratios pertaining to power can also be expressed in terms of decibels provided the resistance or impedance remains constant as follows:

$$db = 20 \log \frac{E2}{E1} \text{ or } db = 20 \log \frac{I2}{I1}$$

The difference in the multiplying factor 20 for voltage or current arises from the fact that power is proportional to voltage or current squared; therefore, the logarithm of that number is there by doubled. Thus, for power ratios the db value is 10 times the logarithm of the ratio. For voltage or current ratios, the db value is 20 times the logarithm or the ratio.

This discussion concerns both the db and dbm reference levels (see Figure 29) and test equipment used in their determination. (The db should not be used to indicate voice levels. The unit of measurement VU is used to express the volume of speech or voice levels in communications systems.) For reference levels as follows:

0 db reference level — 6 milliwatts terminating into a 500-ohm impedance.

0 dbm reference level — 1 milliwatt terminating into a 600-ohm impedance.

Test equipment — AC Voltmeter — 1000 cycle tone source.

0 VU reference level — 1 milliwatt terminating into a 600-ohm impedance.

Test equipment — Calibrated VU meter at 0 dbm level.

The difference between the terms db and dbm is only in the reference level. First example: reference level db: 0 db = 6 milliwatts across 500 ohms; using Ohm's law to find the voltage level required: E equals the square root of WR. Then the value of 6 milliwatts (. 006) times the Ohms (500) equals 3. 0; since the square root of 3. 0 is 1. 73, then the voltage level to produce 6 milliwatts across a 500 ohm load is 1. 73 volts.

Second example: reference level dbm: 0 dbm = 1 milliwatt across 600 ohms: again using Ohm's law to find the voltage level required: E equals the square root of WR. We take W which is one milliwatt (. 001) x the 600 ohms and get . 6, the square root of . 6 is . 774. Therefore, the voltage level for 1 milliwatt across 600 ohms is . 774 volts. Figure 29 shows the comparison between db and dbm.

The terms db or dbm can also be used to express a ratio above or below any reference level. Third example: 3:1 voltage ratio: Three times as much voltage at 1. 73 volts across 500 ohms would result in the voltage level being approximately 10 db higher than the reference level of 0 db; this is usually designated as +10 db. Conversely: 1/3 as much voltage is 1. 73 volts across 500 ohms would result in the voltage level being approximately 10 db lower than the reference level of 0 db and is written as -10 db. A common term used to denote FM receiver noise quieting is 20 db: a voltage ratio of ten to one. The same expression can be applied to dbm. The only difference here would be that of the 0 dbm reference level which is based on . 774 volts across 600 ohms for 1 milliwatt of power; compared to 1. 73 volts across 500 ohms for 6 milliwatts of power in the 0 db reference (Figure 29).

1 MW – 600 OHMS REFERENCE LEVEL VOLTS	dbm or db	6 MW – 500 OHMS REFERENCE LEVEL VOLTS
7.746	+20	17.320
6.153	+18	13.760
4.887	+16	10.930
3.882	+14	8.681
3.084	+12	6.895
2.449	+10	5.477
1.946	+ 8	4.351
1.546	+ 6	3.456
1.228	+ 4	2.745
0.975	+ 2	2.181
0.774	0	1.732
0.616	- 2	1.376
0.488	- 4	1.093
0.388	- 6	0.861
0.308	- 8	0.689
0.244	-10	0.547
0.194	-12	0.435
0.154	-14	0.345
0.122	-16	0.274
0.097	-18	0.218
0.077	-20	0.173

Figure 29. Voltage DBM Reference Chart

D. VOLUME UNITS

The term VU is used to express the volume of speech in a communications system. The VU meter incorporates specially controlled ballistic characteristics. Therefore, only those levels read on a standard VU meter can be expressed in VU.

A reading on an instrument specifically designed for the purpose and calibrated in VU, actually represents the number of db that the actual speech volume level is above or below the 0 VU reference volume. (0 VU as indicated on a VU meter corresponds to the same point on the meter as 0 dbm indicated for a sine wave.) However, only the VU meter can be used to indicate speech level.

For instance, if a VU meter and a dbm meter are used simultaneously at the same metering point to measure a steady state single tone sine wave, the level as read on the VU meter and dbm meter will be numerically equal to the number of db above or below the established reference level.

By the definition of VU and dbm, the values indicated under the 1 milliwatt 600-ohm reference can be applied to both the VU and dbm if a single frequency steady sine wave tone is used.

Reference volume as applied to speech should not be confused with a constant amplitude single frequency sine wave used to calibrate the zero setting on the VU meter. If a VU meter is calibrated to read 0 on a sine wave level of 1 milliwatt into a stated impedance, a speech wave in the same impedance whose intensity is such as to give a reading of 0 will normally have instantaneous power level (peaks) which are several times one milliwatt, but at the same time an average power which is only a small fraction of one milliwatt. Therefore, it is erroneous and misleading to say that the reference volume is one milliwatt.

E. THE MOTOROLA VU METER AND DETERMINING SPEECH LEVELS

Most telephone companies require that speech levels be transmitted at +8 VU maximum as read with a standard VU meter. The VU meter on the Motorola remote control unit is calibrated to read 0 VU for speech line levels of +8 VU. Therefore, levels above or below this 0 reference level on the meter is an indication of the line level above or below +8 VU.

A dbm meter can be used, however, to establish speech levels using a tone and the necessary correction for voice peaks. For unlimited or unclipped speech these instantaneous peak values can be duplicated with a tone that is +18 dbm, that is, the instantaneous peaks of tone. In the case of limited speech such as after a compression amplifier the peaks would be of the order of only +14 dbm.

Therefore, when 0 VU is being shown on the Motorola remote console meter emitting from speech, the instantaneous voltage peak level is +14 dbm (since a compression amplifier is used). The corresponding VU level on the line is +8 VU. The instantaneous peak voltage on the line would then be in the order of 3.882 volts (+14 dbm) with compression, or 6.153 volts (+18 dbm) without compression.

To help clarify the difference between speech and tone levels some measurements were taken using voice and tone. These measurements were taken with the equipment shown in Figure 30.

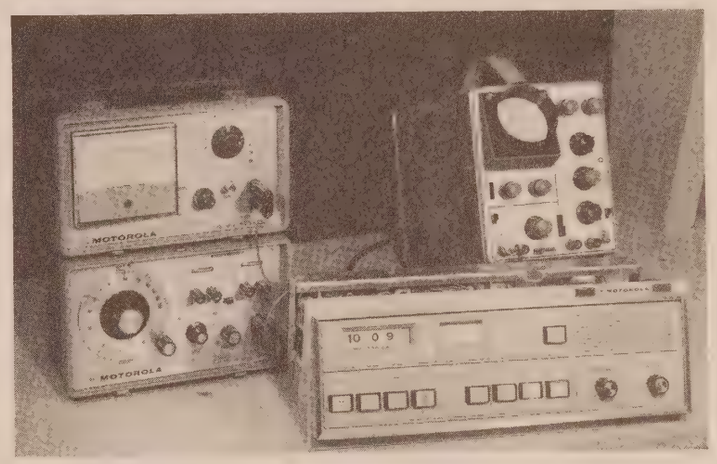


Figure 30. Audio OSC, Transistorized AC Meter, Scope, T1360

A voice signal was fed into a properly set up remote console at an indicated level of 0 VU (see Figure 31). Since the meter is calibrated to indicate 0 VU when +8 VU is applied to the line, the scope placed across the output indicates the peak-to-peak voltage of the voice waveform. Figure 32 shows this waveform and the peak-to-peak voltage is approximately 3.9 volts. Next, an audio oscillator producing a sine wave was fed into the remote console. Its output was adjusted for the same peak-to-peak voltage at the output that the voice signal produced (see Figure 33). When a dbm meter is placed across the output under these conditions, it reads +14 dbm as shown in Figure 34. The range selector switch of the meter is in the +20 dbm position, therefore, a reading -6 dbm is equivalent to (+20 dbm, -6 dbm), or +14 dbm.

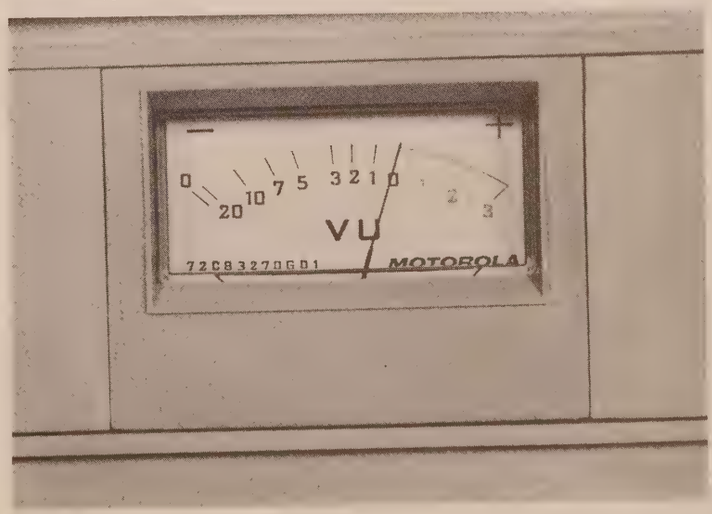


Figure 31. VU Meter

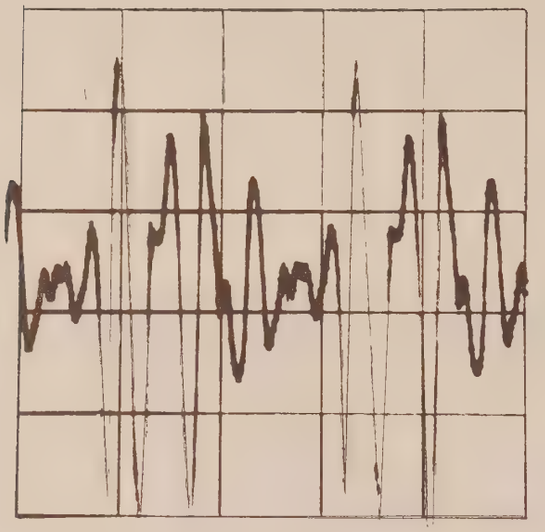


Figure 32. Scope Pattern +8 VU Voice

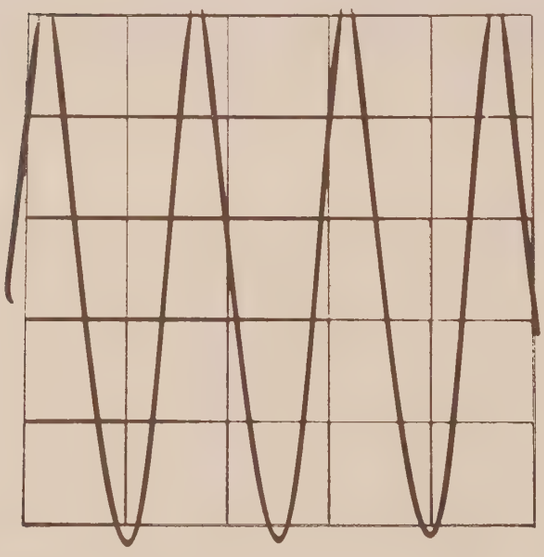


Figure 33. Scope Pattern Sine Wave Peak Same as +8 VU Voice

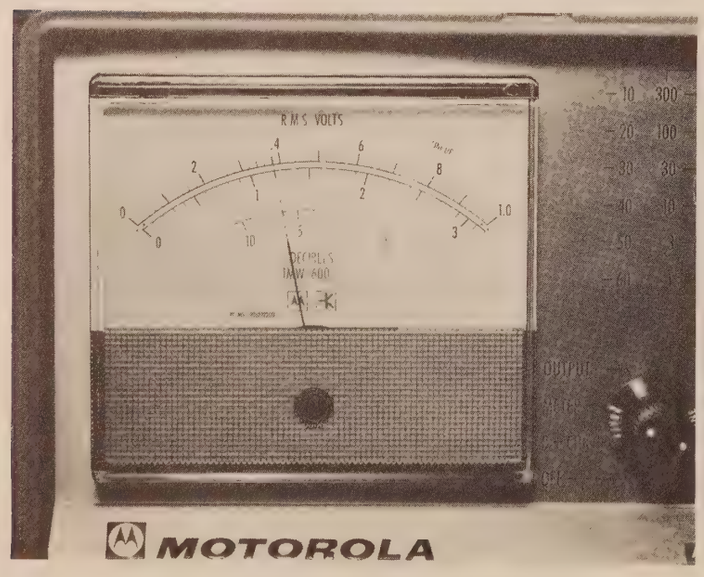


Figure 34. DBM Meter +14 DBM

V. LEVEL ADJUSTMENTS

A. LINE OUTPUT LEVEL

1. GENERAL INFORMATION

The purpose of this adjustment is to provide the correct audio signal level to the remote control line when transmitting. Most telephone companies prescribe a maximum of +8 VU of speech on their lines. This is to prevent crosstalk between pairs in their cables and overhead lines. It is wise to operate your console at the maximum permissible output level since this will result in the best possible signal-to-noise ratio on the line. Make sure the console is terminated with the 600 ohm line (terminals 11 and 12) while making this adjustment.

2. ADJUSTMENT PROCEDURE

The console must be keyed (on transmit) for this adjustment. Grounding terminal 6 is a convenient method for this purpose. Place an AC voltmeter on the Line (terminals 11 and 12) and inject a 1000 cps sine wave signal into the microphone input circuitry (terminals 5 and 8). Adjust the LINE OUT level control for a reading of +14 dbm (3.9 volts) which is the equivalent of +8 VU of speech. If it is desired to use a level lower than +8 VU, adjust the LINE OUT control accordingly. For example, if +3 VU is the desired level, then adjust the LINE OUT level control for +9 dbm (2.2 volts) on the meter. On consoles equipped with a VU meter, the VU meter reading will be "0" regardless of the setting of the LINE OUT level control. This is because the meter is placed ahead of this control in the amplifier circuit so that the operator can always read the VU meter at 70% of its full scale reading regardless of the line level setting. In the preceding example, "0" on the VU meter would indicate +3 VU on the line.

NOTE

If the Motorola TLN8639A Alert Tone Kit is used for this check, its output is sufficient to drive the amplifier well into compression if the jumper on the alert tone board has not been cut.

B. MICROPHONE LEVEL

1. GENERAL INFORMATION

This adjustment is required to provide correct operation of the compression amplifier on transmitted signals. Two important factors enter into the adjustment: (1) the surrounding noise, and (2) the acoustics of the room. If the MIC LEVEL control is adjusted too high, the background noise will be included in the message at a distracting level because the amplifier will compress the operator's voice while amplifying the background noise freely. The result will be a reduced signal-to-noise ratio. Also the "live" acoustics of the average room will cause "hollow" or "boxy" sound-

ing voice reproduction. These conditions seriously detract from the intelligibility of speech. It is important to note that a microphone "exaggerates" any noise in the area. If the microphone level is adjusted too low, the signal will be inadequate to modulate the transmitter to its full capability and the result will be a soft message which cannot always be understood.

2. ADJUSTMENT PROCEDURE

The MIC LEVEL control should be adjusted to a setting just below the point where the compressor begins to operate. On consoles equipped with a VU meter, slowly advance this control until the meter reads "0" on normal voice peaks. Ignore the occasional overshoots produced by emphasized words. In either case, this adjustment procedure should be repeated several times to achieve the best results. On consoles with or without a VU meter, a system listening test is the recommended procedure for setting the microphone level.

It was recommended that the microphone be placed about eight inches from the lips for this adjustment. Experience has shown this to be the best distance for average background noise. If the room is particularly noisy, the operator will have to work closer than eight inches and the MIC LEVEL control must be decreased accordingly. If the room is particularly quiet, the operator may work further away than eight inches and the MIC LEVEL control must be increased accordingly. It must be remembered that the terms "average", "noisy", and "quiet" are all relative.

C. LINE INPUT LEVEL

1. GENERAL INFORMATION

These adjustments are required to provide correct operation of the compression amplifier on the received signals. It is assumed that the base station receiver VOLUME/LINE LEVEL control has been properly adjusted at the station site.

This volume adjustment, described in the base station instruction manual, is a necessary prerequisite to the line input level adjustment. The LINE IN level control should be adjusted to a level just below the point where the compressor begins to operate. The amplifier will then reproduce normal signals at an adequate level for comfortable listening with negligible compression. If this level is set too high, the amplifier will operate in compression all the time and consequently the quality of normal signals will sound unnatural. Compression will also reduce the effective signal-to-noise ratio. This is especially important in systems with "Private-Line" operation where the coding tone audibility will be increased by the same number of db as the voice signal is compressed. Intercom signals are normally higher in level than the remote station signals because of the proximity of their source. Therefore, they will drive the amplifier into compression most of the time. In these instances, the compressor prevents the intercom message from "blasting".

2. ADJUSTMENT PROCEDURE

NOTE

If a line compensator kit is used with a console, compensation must be made before adjusting the line input level.

On consoles equipped with a VU meter, the LINE IN level control should be slowly advanced until the VU meter approaches "0" on voice peaks. Caution should be exercised at this point since it is easy to overshoot this adjustment. This overshooting occurs because the meter continues to read "0" with a further increase. This happens because of compression. On consoles not equipped with a VU meter a system listening test is recommended to adjust the LINE IN level, turning up the level until the speaker level begins to flatten out. This is the knee of compression.

D. BASE STATION LINE INPUT CONTROL ADJUSTMENT

1. GENERAL INFORMATION

The LINE INPUT LEVEL/EXCITER LEVEL control is located in the base station on its remote control chassis. The adjustment of this control is described in the base station instruction manual. However, the success of all of the console adjustments just described are dependent upon the correct setting of this control at the base station. Therefore, its adjustment procedure is repeated here to emphasize its importance.

Up to this point, the console has been adjusted to provide the correct signal into the audio transmission line. Some of this signal will be lost down the line depending upon its nature and length. At the base station end of the line, the LINE INPUT CONTROL/EXCITER LEVEL (on the remote control chassis) acts as an attenuator to set the correct amount of signal into the audio circuit of the transmitter. The setting of this control will depend upon the amount of signal put into the line at the sending end and the length of the line.

2. ADJUSTMENT PROCEDURE

NOTE

If a Motorola TK556 Line Compensator Kit is used, it should be adjusted first before making this adjustment.

Connect a high impedance voltmeter (Motorola model, S1051 or equivalent) across the transmitter audio input terminals. Transmit a 1000 cps test signal from the console at its maximum permissible output level (normally 14 dbm). Adjust the LINE INPUT LEVEL/EXCITER LEVEL control on the base station for the proper voltage as indicated on the IDC Adjustment Procedure

in the base station instruction manual. This adjustment will then provide the correct speech level to the transmitter when the microphone is used at the console.

E. AUDIO LEVEL ADJUSTMENT SPECIAL CONSIDERATIONS

1. MULTIPLE INSTALLATIONS

In multiple installations, that is, where several remote consoles are in parallel on the control line, the level adjustments are made in the same manner as described for a single unit.

First, determine which unit is farthest (electrically) from the transmitter. Care should be used in determining this as in many instances, due to the location of telephone exchanges and cable routings, the remote console physically located the farthest from the transmitter may not be electrically the farthest away.

Once it has been established which unit is electrically the farthest away, this unit is set up exactly as previously described only on the console located the farthest away. It is not changed for setting up the closer consoles. Instead, the LINE OUT level control at each successively closer remote console is adjusted to provide a signal at the base station equal in level to that of the farthest remote. By following this same procedure for each successively closer console, the input level to the transmitter will be the same regardless of which console is being used. This compensates for the variation in line losses. At the same time, the compression amplifier prevents the higher audio level of the farthest unit from being too loud in the closer consoles.

2. TWO-RECEIVER BASE STATION PRIORITY SETUP

It is possible, using the characteristic of the compression amplifier, to set up a two-receiver system such that automatic priority of the received signal is obtained. This is accomplished by setting the level of received audio of the higher priority receiver to a significantly higher level (10 to 20 db) than the other receiver. If the LINE IN control at the console is set at the knee of compression for the low-priority receiver, then its audio will be compressed when the priority receiver audio is present. Meanwhile, separate messages will be held at the same level by the compression amplifier.

F. LINE CURRENT ADJUSTMENT

The control currents are regulated and thus independent of loop resistance up to a maximum of 8000 ohms. The value of the current for all functions is shown in the following chart. Figure 35.

PTT		RECEIVE	
F1	F2	"PL" DISABLE	MUTE RCVR 2
12.5 ma			
12.5 ma		-2 ma	
12.5 ma			-5.5 ma
12.5 ma		-2 ma	-5.5 ma
+5.5 ma	12.5 ma		
+5.5 ma	12.5 ma	-2 ma	
+5.5 ma	12.5 ma		-5.5 ma
+5.5 ma	12.5 ma	-2 ma	-5.5 ma

Figure 35. Current Chart

NOTE

The line currents listed in the chart are adjusted at the factory for operation with Motorola base stations which are equipped with solid-state remote control chassis. For any other base station, check your manual for the required current values. Follow the subsequent procedures for field check or adjustment.

On Motorola transistorized base station, the line currents may be measured using the built-in metering and intercom facilities. Refer to the base station instruction manual for details.

1. CONNECTING TEST EQUIPMENT

Connect an ammeter at the control lines as shown in accompanying Figure 36.

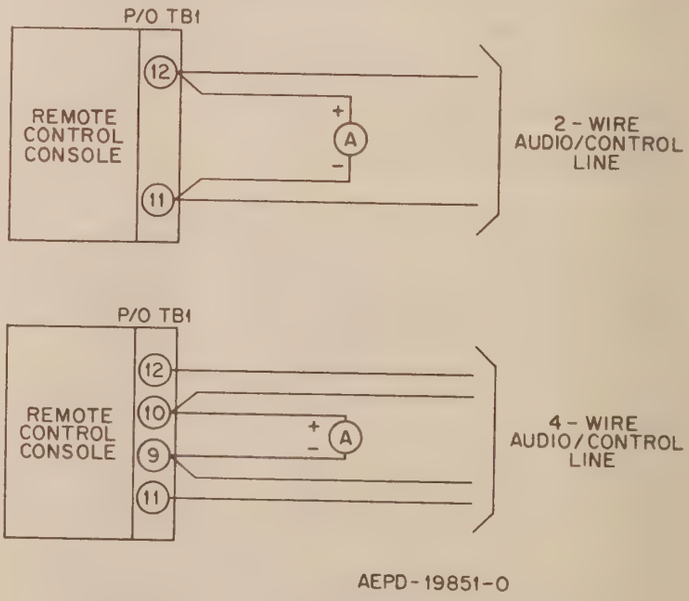


Figure 36. Ammeter Connections for Line Current Adjustment

2. ADJUSTMENT

All adjustments are made with the potentiometers on the TLN8633A Line Current Board at the rear of the console. The console housing must be removed before making these adjustments.

a. On single-frequency models, operate the push-to-talk switch and adjust the F1 potentiometer until a +12. 5 ma reading is obtained.

b. On two-frequency models, select F1 on the frequency selector switch and operate the push-to-talk switch. Adjust the F1 potentiometer until a +5. 5 ma reading is obtained. Switch the frequency selector to F2 and operate the push-to-talk switch. Adjust the F2 potentiometer until a +12. 5 ma reading is obtained.

c. For models equipped with a "PL" MON. switch, press the switch and adjust the "PL" potentiometer until a -2 ma reading is obtained.

d. For models equipped with a mute receiver 2 function, press the RCVR 2 MUTE switch and adjust the MUTE 2 potentiometer until a -5. 5 ma reading is obtained.

NOTE

If after initial adjustment, some change in loop resistance of the control lines occurs, no readjustment is required since the console current regulators will provide a fixed current on the lines regardless of line resistance.

VI. TROUBLESHOOTING PROCEDURE

A. GENERAL

Servicing of the transistorized remote control console requires the localizing of the malfunctioning circuit before the defective component can be isolated and replaced. Since localizing and isolating a defective component constitutes the most time-consuming part of troubleshooting, a thorough understanding of the circuits involved will aid the technician in performing efficient servicing. The technician must know how one function affects another; he must be familiar with the overall operation of the remote control console and the procedures necessary to place the console back in operation in the shortest possible time.

The console block and schematic diagrams provide valuable information for troubleshooting purposes. The block diagram provides signal flow information in a simplified format while the schematic diagram provides the detailed circuitry and the biasing voltages required for isolating malfunctioning components. Generally, it may be assumed that if the console is totally inoperative, the power inputs or power supplies are defective. However, if the console operates in the transmit mode but not in the receive mode (or vice versa), it may be assumed that the power supplies are serviceable and that one or more functional circuits are defective or marginal. By using the block diagram and deductive processes, the suspected circuit may be readily found.

The following procedures outline a quick sequence of checks using the AUDIO "A" test point (output of compression amplifier terminal 17) for localizing malfunctions.

B. TEST EQUIPMENT REQUIRED

1. Motorola Solid State DC Multimeter (or equivalent).

2. Motorola Solid State AC Voltmeter (or equivalent).

3. Motorola Model T1034C FM Signal Generator (or equivalent).

4. Motorola Transistorized Tone Generator (or equivalent).

NOTE

Although it is not used in the following condensed troubleshooting procedures, a general purpose oscilloscope (Motorola Model T1015A, or equivalent) is very useful in localizing problem areas.

C. ON-SITE TEST PROCEDURE

1. Remove the remote control console housing to gain access to the rear terminal panel.

2. Check that the power cable(s) is (are) connected, that the console OFF-ON switch is in the ON position and that the green power-on lamp is lighted.

3. Using the DC multimeter, check the output level of the low-voltage power supply. The output should be set for +13. 8 volts DC.

4. Connect the AC voltmeter across terminal 17 (AUDIO "A") and chassis ground and proceed with the test as indicated in the following table (Figure 37).

TEST PROCEDURE

STEP	ACTION	NORMAL INDICATION	ABNORMAL INDICATION	PROBABLE CAUSE	CORRECTIVE ACTION
1	Use P-T-T and transmit a message to outlying mobile or base station.	Meter indicates .8 volts rms and outlying station receives message. Proto step 2.	Meter indicates .8 volt rms but outlying station does not receive message.	Defective transmit amplifier circuitry or transistor switch.	Refer to schematic diagram and measure bias voltages to determine defective component.
			Less than .8 volt rms and no message received.	Defective compression amplifier and/or microphone bias circuitry.	Same as above.
2	Outlying base or mobile transmits a message to console.	Meter indicates .8 volt rms and message is heard at console speaker. Console operative.	Meter indicates .8 volt rms but message is not heard.	Defective 5-watt amplifier or associated transistor switch.	Refer to schematic diagram and measure bias voltages to determine defective component.
			Less than .8 volt rms and message is not heard.	Defective receive amplifier, its associated transistor switch or compression amplifier.	Same as above.

Figure 37. Test Procedure Chart

D. BENCH-TEST PROCEDURE

1. Remove console housing.

2. Connect remote control console to a 117-volt AC source and rotate OFF-ON switch to ON position. Green lamp lights.

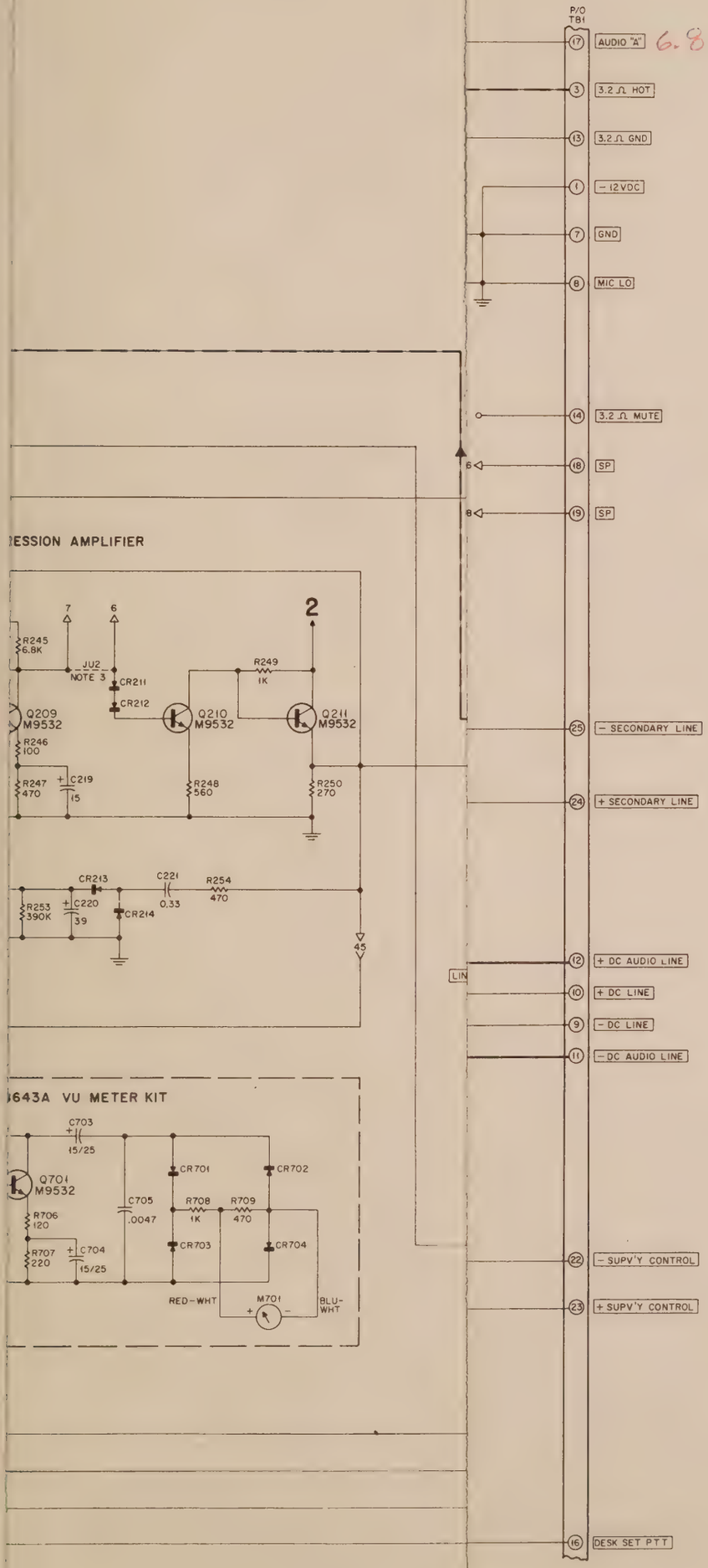
3. Connect AC voltmeter across terminal 17 (AUDIO "A") and chassis ground.

4. Connect the audio signal generator across line transformer terminals 11 and 12.

5. Turn on the audio signal generator and adjust for a 1000 cycle output at 0 dbm level.

6. With the test tone applied, the meter should indicate .8 volt rms at the output of the compression amplifier and the tone should be heard via the console speaker. If the tone is not audible and .8 volt rms is measured at the output of the compression amplifier, check the 5-watt amplifier circuitry and its associated switch by taking measurements of the bias voltages. If the tone or .8 volt rms is not present, check the receiver amplifier, its associated switch and the compression amplifier circuitry.

7. Disconnect the audio signal generator from the line transformer and connect it across the microphone input (terminals 5 and 6). Adjust the audio signal generator for a 200 mv output level. Actuate the P-T-T function by connecting a ground to terminal 6. With the audio signal generator input present, the meter should indicate .8 volt rms at terminal 17. If the compression amplifier output indicates normal, use the meter to measure the output of the transmit amplifier. The output level should be approximately +14 dbm. If no output is present, check the transmit amplifier and associated switch circuitry. If .8 volt rms is not indicated at the output of the compression amplifier, check the amplifier and its associated circuitry.


P/O TB1
17 AUDIO "A"
6.8 DC .8 VAC
3 3.2 Ω HOT
13 3.2 Ω GND
1 - 12 VDC
7 GND
8 MIC LO
14 3.2 Ω MUTE
18 SP
19 SP
ESSION AMPLIFIER
7
6
2
R245 6.8K
JU2 NOTE 3
CR211
CR212
R249 1K
Q209 M9532
Q210 M9532
Q211 M9532
R246 100
R247 470
C219 15
R248 560
R250 270
25 - SECONDARY LINE
24 + SECONDARY LINE
CR213
C221 0.33
R254 470
R253 390K
C220 39
CR214
45
12 + DC AUDIO LINE
10 + DC LINE
9 - DC LINE
11 - DC AUDIO LINE
643A VU METER KIT
C703 15/25
Q701 M9532
CR701
CR702
C705 .0047
R708 1K
R709 470
R706 120
R707 220
C704 15/25
CR703
CR704
RED-WHT
M701
BLU-WHT
22 - SUPV'Y CONTROL
23 + SUPV'Y CONTROL
16 DESK SET PTT

TEST PROCEDURE

STEP	ACTION	NORMAL INDICATION	ABNORMAL INDICATION	PROBABLE CAUSE	CORRECTIVE ACTION
1	Use P-T-T and transmit a message to outlying mobile or base station.	Meter indicates .8 volts rms and outlying station receives message. Pro- to step 2.	Meter indicates .8 volt rms but outlying station does not receive message.	Defective transmit amplifier circuitry or transistor switch.	Refer to schematic diagram and measure bias voltages to determine defective component.
			Less than .8 volt rms and no message received.	Defective compression amplifier and/ or microphone bias circuitry.	Same as above.
2	Outlying base or mobile transmits a message to console.	Meter indicates .8 volt rms and message is heard at console speaker. Console operative.	Meter indicates .8 volt rms but message is not heard.	Defective 5-watt amplifier or associated transistor switch.	Refer to schematic diagram and measure bias voltages to determine defective component.
			Less than .8 volt rms and message is not heard.	Defective receive amplifier, its associated transistor switch or compression amplifier.	Same as above.

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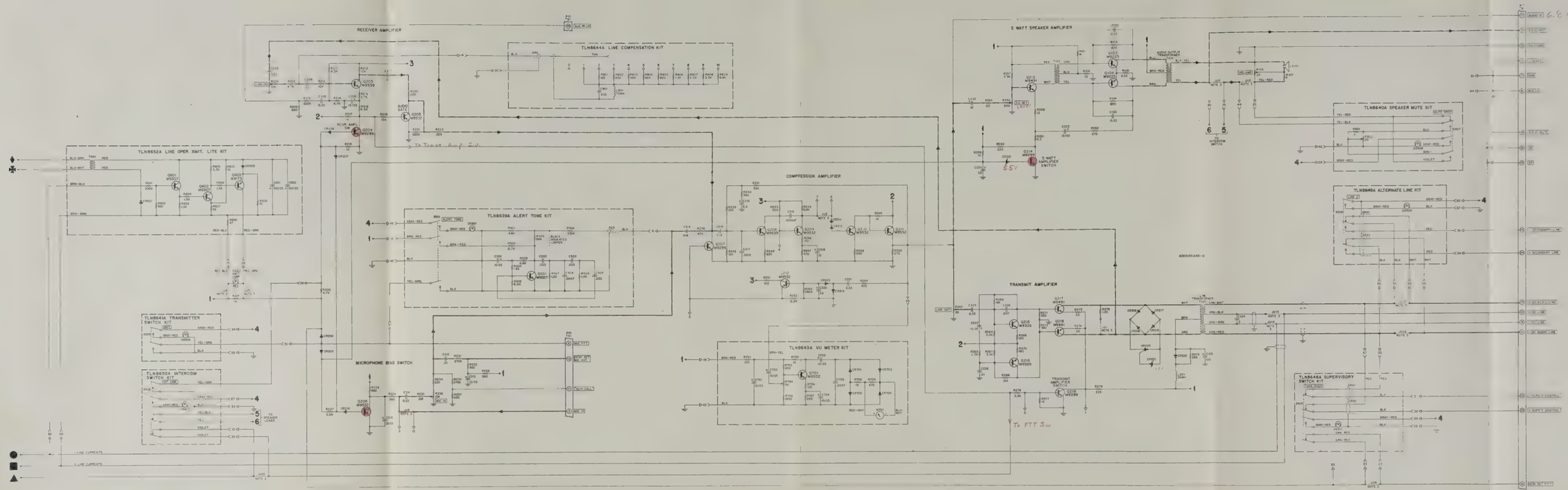
3. Connect AC voltmeter across terminal 17 (AUDIO "A") and chassis ground.

4. Connect the audio signal generator across line transformer terminals 11 and 12.

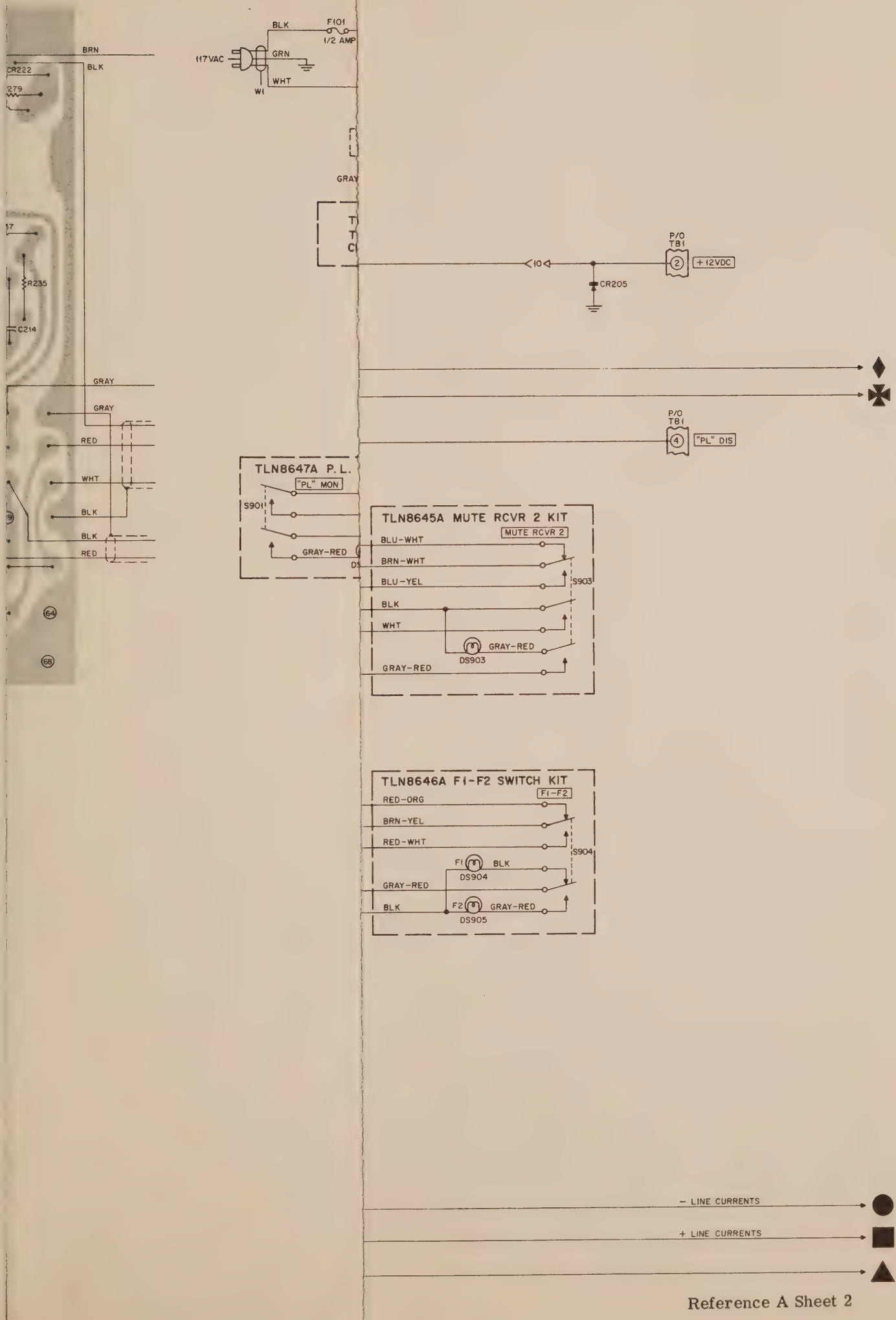
5. Turn on the audio signal generator and adjust for a 1000 cycle output at 0 dbm level.

6. With the test tone applied, the meter should indicate .8 volt rms at the output of the compression amplifier and the tone should be heard via the console speaker. If the tone is not audible and .8 volt rms is measured at the output of the compression amplifier, check the 5-watt amplifier circuitry and its associated switch by taking measurements of the bias voltages. If the tone or .8 volt rms is not present, check the receiver amplifier, its associated switch and the compression amplifier circuitry.

7. Disconnect the audio signal generator from the line transformer and connect it across the microphone input (terminals 5 and 6). Adjust the audio signal generator for a 200 mv output level. Actuate the P-T-T function by connecting a ground to terminal 6. With the audio signal generator input present, the meter should indicate .8 volt rms at terminal 17. If the compression amplifier output indicates normal, use the meter to measure the output of the transmit amplifier. The output level should be approximately +14 dbm. If no output is present, check the transmit amplifier and associated switch circuitry. If .8 volt rms is not indicated at the output of the compression amplifier, check the amplifier and its associated circuitry.



Reference A Sheet 1


BRN
BLK
CR222
279
R235
C214
GRAY
GRAY
RED
WHT
BLK
BLK
RED
64
68
117VAC
BLK
F101
1/2 AMP
GRN
WHT
W1
GRAY
10
CR205
P/O TB1
2
+12VDC
P/O TB1
4
"PL" DIS
TLN8647A P.L.
"PL" MON
S901
GRAY-RED
TLN8645A MUTE RCVR 2 KIT
MUTE RCVR 2
BLU-WHT
BRN-WHT
BLU-YEL
BLK
WHT
GRAY-RED
DS903
GRAY-RED
S903
TLN8646A F1-F2 SWITCH KIT
F1-F2
RED-ORG
BRN-YEL
RED-WHT
F1
BLK
DS904
GRAY-RED
F2
GRAY-RED
BLK
DS905
S904
– LINE CURRENTS
+ LINE CURRENTS

VOLTAGE READINGS

Refer to notes 14, 15 and 16.

CIRCUIT STAGE CONDITIONS

CIRCUIT STAGE	MODE OF OPERATION: TRANSMIT (Note 12) MIKE	DESK SET	INTERCOM (Note 13)	RECEIVE
5 Watt Speaker Amplifier	OFF	ON	ON	ON
Transmit Amplifier	ON	ON	ON	OFF
Microphone Bias Switch	HOT	DISABLED	HOT	DISABLED
Receive Amplifier	OFF	OFF	OFF	ON
P-T-T Switch	ON	ON	OFF	OFF

5 WATT SPEAKER AMPLIFIER

		OFF	ON
Q103	E	0.02	0.02
	B	0.5	0.5
	C	13.8	13.8
Q104	E	0.02	0.02
	B	0.5	0.5
	C	13.8	13.8
Q213	E	9.6	0.9
	B	1.7	1.5
	C	13.8	11.3
Q214	B	0.02	0.8
	C	9.7	0.2

TRANSMIT AMPLIFIER

		ON	OFF
Q215	E	10.1	9.8
	B	9.4	9.1
	C	1.6	1.6
Q216	E	10.1	9.8
	B	9.5	9.2
	C	1.6	1.6
Q217	E	0.9	9.6
	B	1.6	1.7
	C	11.7	13.8
Q218	E	1.0	9.4
	B	1.6	1.7
	C	11.8	13.8
Q219	B	0.8	0.03
	C	0.5	9.8

P-T-T SWITCH

		ON	OFF
Q301	E	0.7	0.0
	B	1.5	0.1
	C	0.9	13.6
Q302	B	0.7	0.0
	C	0.1	16.2

MICROPHONE BIAS SWITCH

		HOT	DISABLED
Q206	B	0.2	0.8
	C	7.1	0.1

RECEIVER AMPLIFIER

		OFF	ON
Q203	E	7.0	3.7
	B	4.3	4.2
	C	12.0	8.0
Q204	B	0.0	0.7
	C	7.3	0.1
Q205	B	0.7	0.1
	C	9.0	0.0

COMPRESSION AMPLIFIER

Q207	B	0.4
	C	0.0
Q208	E	0.4
	B	1.0
	C	1.0
Q209	E	0.7
	B	1.0
	C	3.9
Q210	E	2.2
	B	3.0
	C	7.4
Q211	E	6.8
	B	7.4
	C	10.7
Q212	E	10.4
	B	1.0
	C	12.0

ALERT TONE

Q501	B	0.7
	C	1.9

DC-DC CONVERTER

Q401	B	3.7 rms (-2.5 avg)
	C	13.8
Q402	B	3.7 rms (-2.5 avg)
	C	13.8
Q403	E	13.8
	B	12.9
	C	13.5

VU METER

Q701	E	2.2
	B	2.9
	C	7.5

13.8 V DC REGULATED POWER SUPPLY

Q101	E	13.8
	B	14.9
	C	22.0
Q201	E	14.4
	B	14.9
	C	22.0
Q202	E	6.8
	B	7.7
	C	14.9

LINE OPERATED TRANSMIT LIGHT (Note 18)

		Light On	Light Off
Q601	E	16.6	25
	B	15.5	24.5
Q602	E	18	24
	B	17.2	25
	C	17.8	0.0
Q603	E	0.9	0.8
	B	1.8	0.0
	C	1.1	25.0

CURRENT REGULATORS (Note 17)

		F1	F2	PL-MON	MUTE-RX
Q102 (+)	E	5.0	5.0	0.0	0.0
	B	5.6	5.6	0.0	0.0
	C	185	100	228	220
Q102 (-)	E	0.0	0.0	5.9	5.9
	B	0.0	0.0	5.9	5.9
	C	208	200	215	185
C302 (+)		220	204	0.0	0.0
C301 (-)		0.0	0.0	230	220

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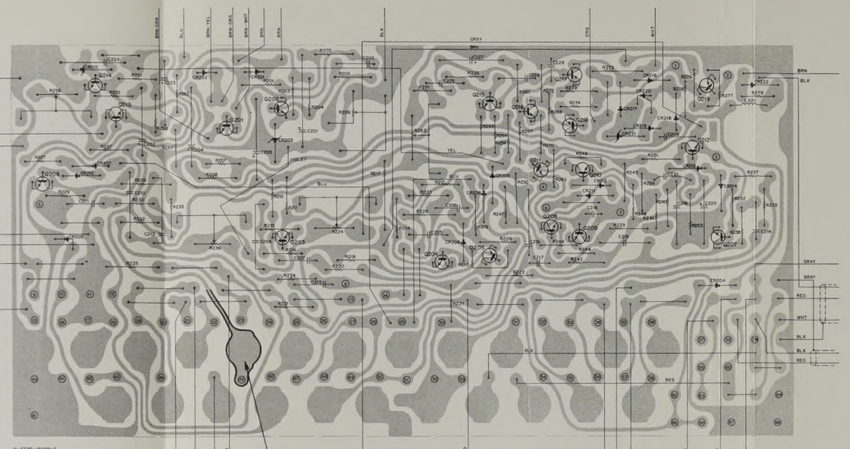

Amplifier Circuit Board Detail

NOTES:

1. OPTIONAL KITS SHOWN IN DASHED ENCLOSURES.
2. JUMPERS AND MALE PIN CONNECTORS APPEARING ON THE SCHEMATIC ARE MOUNTED ON THE CURRENT AND AMPLIFIER BOARDS. THESE PINS ARE IDENTIFIED BY A STAMPED NUMBER ADJACENT TO THE PIN.
3. REFER TO THE JUMPER CHART IN THE INSTALLATION SECTION FOR ALL INFORMATION.
4. ⟨⟩ INDICATES EQUIPMENT MARKING.
5. SEE PARTS LIST FOR RESISTOR WATTAGE RATINGS.
6. UNLESS OTHERWISE STATED, CAPACITOR VALUES ARE IN MICROMICRO-FARADS.
7. 117 VOLT AC MODELS ONLY.
8. 117 VOLT AC/12 VOLT DC MODELS ONLY.
9. HEAVY LINES ARE AUDIO PATHS:
   ▬▬ = TRANSMIT AUDIO
   ▬▬ = RECEIVE AUDIO
10. SINGLE PLASTIC INSULATED CONNECTORS.
11. CONVERTERS ARE IDENTICAL.
12. CIRCUIT CONDITIONS SAME FOR F1 OR F2 OPERATION.
13. SPEAKER IS DISCONNECTED IN THE INTERCOM MODE.
14. ALL MEASUREMENTS OBTAINED USING A 20,000 OHM/VOLT DC METER.
15. ALL MEASUREMENTS MADE WITH RESPECT TO CHASSIS GROUND UNLESS OTHERWISE STATED.
16. EMITTER VOLTAGE OF TRANSISTOR IS AT GROUND POTENTIAL WHEN NOT INDICATED.
17. ALL READINGS OBTAINED WITH THE NEGATIVE PROBE OF THE METER ON THE NEGATIVE SIDE OF CAPACITOR C301.
18. ALL READINGS OBTAINED WITH THE NEGATIVE PROBE OF THE METER ON THE NEGATIVE SIDE OF CAPACITOR C601.

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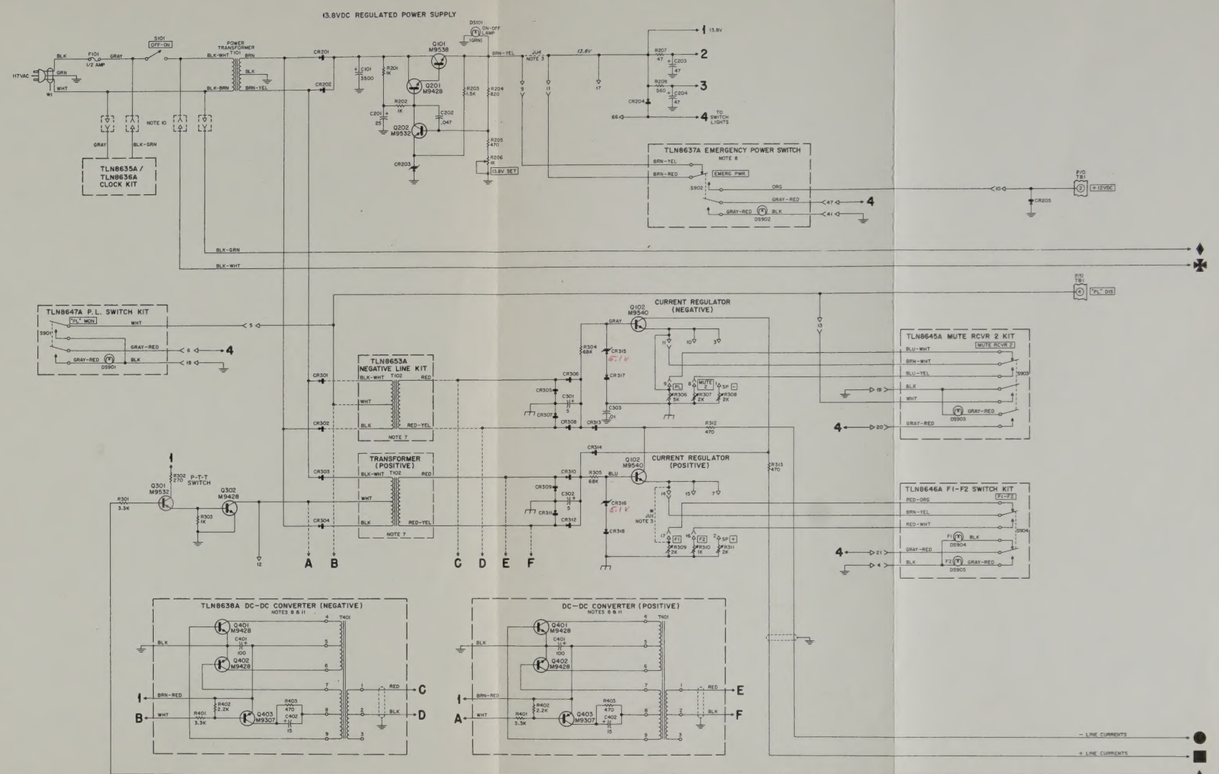

Reference A Sheet 2